QL
1
K7
v.38
no.5&6
Physical &
Applied Sci
Serials

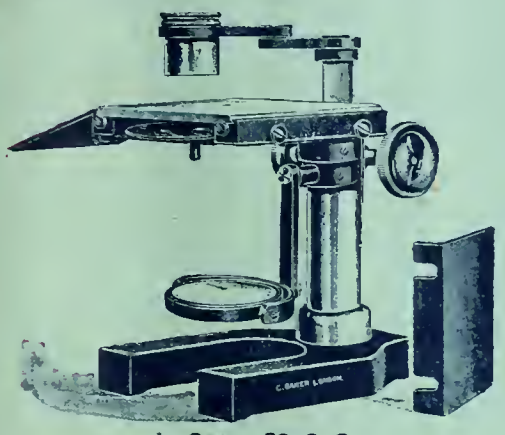
Knowledge

LIBRARY
SEP 27 1968
TORONTO

VOLUME XXXVIII. NUMBER 561. APRIL, 1915. ONE SHILLING NET.
New Series. Volume XII. Part 4. Founded by Richard A. Proctor, 1881. Registered for Canadian and
Entered at Stationers' Hall. Articles:—Plainly Worded. Subjects:—Exactly Described. Newfoundland Magazine Postage.

STORAGE

C. BAKER'S LARGE DISSECTING MICROSCOPE.



In Case, £2 9 6
With Aplanatic Lenses ×10 and ×20 .. £3 6 0
Extra ,, ,, × 8 ,, ×15 .. each 11 0
Catalogue post free on request.
244, HIGH HOLBORN, LONDON.

NEWTON & CO.'S "VITASCOPE"
Invaluable to the Botanist or Naturalist.

THIS ENTIRELY NOVEL INSTRUMENT, designed at Naples University, removes the difficulty of examining and observing living insects, and watching their movements, in the garden or house, under high magnification, without removing them from their natural surroundings, disturbing or frightening them. The "**Vitascope**" is neither a microscope nor a telescope, but a combination of both instruments. It can be used in the hand, or on a stand, at will, and fills a long-felt want in Natural History Research.

The magnification can be varied from 12 to 60 diameters.

Price 84/- with Table Stand (as illustrated) in case complete. Tall Garden Stand, 5/- extra.
Descriptive Pamphlet post free. **Sole Makers: NEWTON & Co.**

NEW AUSTRALIAN BRANCH.
Temporary Address: NEWTON & Co.,
c/o **BANK OF AUSTRALASIA,**
MARTIN PLACE, SYDNEY, N.S.W.

NEWTON & CO., By Royal Warrant to H.M. King George V and the Government, **72, WIGMORE ST., LONDON, W.**
Telegrams: "Newtobar, Wesdo, London."] Established over 200 Years. [*Telephone:* Mayfair 2339.

A most acceptable Gift at any time.

KNOWLEDGE VOLUME FOR 1914.

Containing **440 Pages** with **425 Illustrations,** many being Full Page Plates.
Bound in Blue Cloth, Gilt Design and Lettering, **15/-** net, post free within the United Kingdom.

Publishing Office: AVENUE CHAMBERS, BLOOMSBURY SQUARE, LONDON, W.C., or through any Bookseller.

Just published. **15/-** net. 500 pp.
Numerous illustrations.

Dante and the Early Astronomers.

By M. A. ORR
(Mrs. JOHN EVERSHED, Kodaikanal).

A study of the ideas of the early astronomers, and their relation to mediaeval thought, as revealed in the numerous astronomical references found in Dante's works.

NORTON'S STAR ATLAS
and Telescopic Handbook.

5/- net. NORTONS STAR ATLAS

5/- net. 16 Charts, covering the Star sphere, showing nearly all objects in Webb's Celestial Objects to 7th magnitude, and Smyth's Celestial Cycle.
Prepared with greatest care by A. P. NORTON, B.A.
Positions for 1921.

GALL & INGLIS, 31, Henrietta St., London, W.C.

CHEMICAL, PHYSICAL, and SCIENTIFIC APPARATUS, CHEMICALS, REAGENTS,
Etc., Etc.

MICROSCOPES & ACCESSORIES

BIOLOGICAL INSTRUMENTS

J. Woolley, Sons & Co. Ltd.
Victoria Bridge, Manchester.
CATALOGUES ON APPLICATION.

Prism Binoculars
FOR SALE AND WANTED

CLARKSON'S,
338 High Holborn, LONDON, W.C.
(Opposite Gray's Inn Road.)

IMPERIAL COLLEGE
OF SCIENCE AND TECHNOLOGY

SOUTH KENSINGTON, LONDON, S.W.

Department of Zoology.

The following Courses of Advanced Lectures will be delivered in the Department after Easter:—

(1) A Course of about 20 Lectures with Practical Work on

"PROTISTOLOGY,"

By C. CLIFFORD DOBELL, M.A.

On Mondays, Wednesdays, and Fridays at 10 a.m., beginning Friday, April 23rd.

(2) A Course of about 16 Lectures with Practical Work on

"ECONOMIC ENTOMOLOGY,"

By PROFESSOR H. MAXWELL LEFROY.

On Wednesdays and Fridays at 2 p.m., beginning Friday, April 23rd.

(3) A Course of about Seven Lectures, beginning Monday, April 26th, entitled—

"INTRODUCTION TO THE STUDY OF HEREDITY,"

By PROFESSOR E. W. MACBRIDE, D.Sc., F.R.S.

On Mondays at 5 p.m.

(N.B.—This Course is a continuation of the Course delivered previous to Easter.)

For Terms and Fees apply to the Registrar.

BIRKBECK COLLEGE,

BREAMS BUILDINGS, CHANCERY LANE, E.C.

COURSES OF STUDY (Day and Evening) for Degrees of the UNIVERSITY OF LONDON in the

FACULTIES OF SCIENCE & ARTS

(PASS AND HONOURS)

under RECOGNISED TEACHERS of the University.

SCIENCE.—Chemistry, Physics, Mathematics (Pure and Applied), Botany, Zoology, Geology.

ARTS.—Latin, Greek, English, French, German, Italian, History, Geography, Logic, Economics, Mathematics (Pure and Applied).

Evening Courses for the Degrees in Economics and Laws.

POST-GRADUATE AND RESEARCH WORK.

SESSIONAL FEES: { *Day*: Science, **£17 10s.**; Arts, **£10 10s.** *Evening*: Science, Arts, or Economics, **£5 5s.**

MATRICULATION COURSES AND ACCOUNTANCY.

Prospectuses post free, Calendar 3d. (by post 5d.), from the SECRETARY.

GRESHAM LECTURES.

The Gresham Lecturer on Astronomy, Mr. ARTHUR R. HINKS, M.A., F.R.S., will deliver a Course of Four Lectures on

THE SUN

On TUESDAY, WEDNESDAY, THURSDAY, & FRIDAY, 13th, 14th, 15th, 16th APRIL, 1915.

At Six o'clock in the Evening,

At GRESHAM COLLEGE, BASINGHALL STREET, E.C.

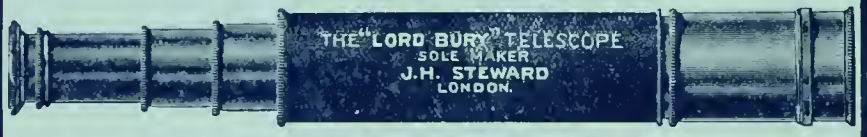
THE LECTURES ARE FREE TO THE PUBLIC.

OUR INFORMATION BUREAU

will be found to be of great use to Foreign and Colonial readers. Oftentimes information is desired which is unobtainable locally, and in such cases, whether the information is of a Literary, Scientific, Trade, or other character, we undertake, for a small fee, to supply the information desired, if at all obtainable; and in order to introduce our Bureau to the notice of the readers of *Knowledge* we will, for a limited period supply such information at the rate of 6d. per enquiry. Stamps (Foreign or British) will be accepted in payment of the Enquiry Fee, and replies will be forwarded by the earliest possible mail. We also act as Buying Agents for readers resident in the provinces or abroad. Full particulars sent gratis.

E. GEORGE & SONS, 23 Jacob Street, London, S.E., England.

TELESCOPES.



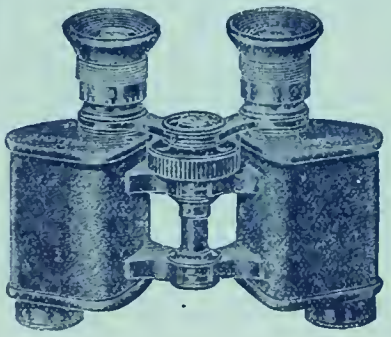
THE "LORD BURY" TELESCOPE, bronzed brass, in sling case £4 4 0

Size, closed, 10 inches; extended, 31 inches. Diameter of Object Glass, 1⅝ inches.

Magnifying power 25 diameters, increasing by pancratic tube to 35 diameters.

Angular Field 1·5°. Lateral Field at 1,000 yds. = 26·2 yds.

Will show a Flagstaff at 22 miles.
,, read name of Lightship at 9 miles.
Will make out Wild Fowl at 16 miles.
,, show time by Church Clock at 6 miles.



THE STEWARD PRISM BINOCULAR

£5 15 0 in sling case.

Central focussing adjustment. Sealed bodies. Suitable for use in hot climates.

Magnifying Power .. × 8 diameters.

Angular Field .. .. 5°

Either of the above sent post free on receipt of remittance.

Illustrated Catalogue, Part I, post free.

J. H. STEWARD, Ltd. Opticians to the British and Foreign Governments,

406 STRAND; 457 WEST STRAND, LONDON. ESTAB. 1852.

WATKINS AND DONCASTER,

NATURALISTS and Manufacturers of

CABINETS AND APPARATUS ::

- FOR -

COLLECTORS OF INSECTS, BIRDS' EGGS AND SKINS, MINERALS, PLANTS, Etc.

Lovers of Birds who wish to encourage them to nest in their gardens or shrubberies should apply for our Price List of Nesting Boxes.

A LARGE STOCK OF INSECTS, AND BIRDS' EGGS AND SKINS.

SPECIALITY.—Objects for Nature Study, Drawing Classes, &c.

Birds, Mammals, etc., Preserved and Mounted by First-class Workmen true to Nature.

☛ **All Books and Publications on Natural History supplied.**

36, Strand, London, W.C.

(Five Doors from Charing Cross.)

☛ *CATALOGUE POST FREE.*

SCIENCE PROGRESS IN THE TWENTIETH CENTURY.

A QUARTERLY JOURNAL OF SCIENTIFIC WORK AND THOUGHT.

Edited by SIR RONALD ROSS, K.C.B., F.R.S., N.L., D.Sc., LL.D., M.D., F.R.C.S.

APRIL. **176 Pages.** **Illustrated.** **5s. net.**

Some Aspects of the Atomic Theory. PROF. F. SODDY, F.R.S.

The Electrical Properties of Conductors at Very Low Temperatures. FRANCIS HYNDMAN, B.Sc.

The Anthocyan Pigments. ARTHUR E. EVEREST, M.Sc., PH.D.

Vertebrate Palæontology in 1914. R. LYDEKKER F.R.S.

The Prevision of Earthquakes. CHARLES DAVISON, Sc.D., F.G.S.

Is the Organism a Thermodynamic Mechanism? JAMES JOHNSTONE, D.Sc.

Notes: The British Science Guild and the Fight for Science—The Fools' War—The Quality of the German Lie—A Converted Pacifist—Our Unspeakable Cranks—and other Notes.

Correspondence: Elementary Logic (A. SIDGWICK)—**Party Politics and Scientific Representation** (A. J. GRAY, Secretary The Proportional Representation Society).

Essay-Reviews: Character and the Emotions (DR. F. W. MOTT, F.R.S.)—**Plagiarism in Science** (THE EDITOR)—**Mathematical Text-books** (AMATEUR)—**Fact and Fancy in Hæmatology** (H. C. ROSS).

Reviews of Thirty-three Books on Mathematics, Physics, Chemistry, Geology, Palæontology, Zoology, Botany, and Applied Sciences. Index.

JOHN MURRAY, ALBEMARLE STREET, LONDON, W.

Symons's Meteorological Magazine.

Edited by HUGH ROBERT MILL, D.Sc.

This Illustrated Magazine, founded in 1866, is devoted to the science of Meteorology in all its branches.

The monthly Climatological Table of the British Empire and the monthly Rainfall Map of the Thames Valley are unique features. Special attention is given to Correspondence from Meteorologists and Observers. The meetings of Meteorological Societies are punctually reported. All important Books bearing on Meteorology are reviewed. Original Articles and descriptions of New Apparatus frequently appear. Exceptional Conditions of Weather in the British Isles are discussed while still remembered.

Published on the 16th of each month. Price 4d., or 5s. per annum post free to any part of the world.

☞ *A Specimen Number will be sent free on application to the Editor at 62, Camden Square, London, N.W.*

Published by EDWARD STANFORD, Ltd., 12, 13, & 14, Long Acre, London, W.C.

POPULAR ASTRONOMY.

TWENTY-TWO VOLUMES COMPLETED.

A Journal for Reference on Current Astronomy.

Over 500 Pages of Reading Matter fully Illustrated in each Volume.

Containing the Latest Astronomical News. Articles on Astronomical Themes. Many Fine Engravings. Spectroscopic, Planet and Comet Notes. Star Charts every Month.

A Valuable Journal in any General Library.

Subscription to the Twenty-third Volume (ten numbers) post free to any address in the United States on receipt of 3 dollars 50 cents; Canada, 3 dollars 75 cents; and 16s. 6d. for all other countries. Preceding volumes at same price.

EDITORS: HERBERT C. WILSON, RALPH E. WILSON, AND CURVIN H. GINGRICH.

GOODSELL OBSERVATORY OF CARLETON COLLEGE, **NORTHFIELD, MINN., U.S.A.**

WILLIAM WESLEY & SON, 28 Essex Street, Strand, London.

MAN

An illustrated monthly record of Anthropological Science, 1/- per part, 10/- a year, post free anywhere.

CONTENTS OF 1PRIL ISSUE.

ORIGINAL ARTICLES: John Batman's Title Deeds. (*With Plates D and E*).—Were the Pre-Dynastic Egyptians Libyans or Ethiopians?—Notes on some Japanese Coins and Coin-like Objects used as Amulets and in Charms. REVIEWS: *Native Tribes of the Northern Territory of Australia. Les Temples Immergés de la Nubie: The Temple of Derr. The Handbook of Folklore. The Bronze Age in Ireland.—Traité des Variations de la colonne vertébrale de l'Homme et de leur signification au point de vue de l'Anthropologie Zoologique.*

London: The Royal Anthropological Institute, 50, Great Russell St.

General Agent: FRANCIS EDWARDS, 83, High Street, Marylebone, London W.

BOOKS

on Scientific, Technical, Educational, Medical, all other subjects, and for all Exams.

SECOND-HAND AT HALF PRICES.

New, at 25 % Discount.

CATALOGUES FREE. State wants. Books sent on approval.

BOOKS BOUGHT—BEST PRICES GIVEN.

W. & G. FOYLE, 121-123, Charing Cross Road, London, W.C.

Fourth Edition. Enlarged. Pp. xviii+426, with 113 Illustrations, including 5 Plates. Price **6s.** net (postage 5d.).

CROSS & COLE'S MODERN MICROSCOPY

A Handbook for Beginners and Students.

With Chapters on Special Subjects by

C. ANDREWS, F.R.M.S.; F. J. CHESHIRE, F.R.M.S.; A. EARLAND, F.R.M.S.; C. F. ROUSSELET, F.R.M.S.; T. H. RUSSELL, F.L.S.; C. D. SOAR, F.L.S., F.R.M.S.; and W. MARK WEBB, F.L.S.

¶ *Mr. J. E. Barnard (Lecturer in Microscopy at King's College), reviewing this book in "Knowledge," says: "It may with confidence be recommended as a safe guide for those entering on any field of work that involves the use of the microscope."*

BAILLIÈRE, TINDALL & COX, 8, Henrietta Street, Covent Garden, London.

The Leading Journal of Science.

SIXPENCE WEEKLY.

Attention is directed to a few of the *topical* articles which have appeared in NATURE since the outbreak of the war: "Science and the State" (*October* 29); "The Manufacture of Dyestuffs in Britain: a Summary and an Appeal" (*January* 21); "Synthetic Drugs in Great Britain" (*January* 28); "The Manufacture of Dyestuffs" (*February* 11); "Chemistry and Industry" (*February* 18); "The Manufacture of Dyestuffs" (*February* 25); "Duty-free Alcohol for Scientific Purposes" (*March* 4); "Science and Industry" (*March* 18); "Periscopes" (*March* 18); "Oil of Vitriol as an Agent of 'Culture'" (*March* 18); "Scientific Factors of Industrial Success" (*March* 25); "Supplies of Laboratory and Optical Glass Apparatus" (*March* 25). Any one number will be sent by post on receipt of its published price, plus postage.

Office: St. Martin's Street, London, W.C.

National Relief Fund.

THE PRINCE TO THE PEOPLE.

Buckingham Palace.

"At such a moment we all stand by one another, and it is to the heart of the British people that I confidently make this most earnest appeal."

EDWARD P.

To H.R.H. The Prince of Wales, Buckingham Palace, London.

I beg to enclose £ : s. d as a donation to the National Relief Fund.

Name.....

Address.....

.....

The envelope containing this coupon need not be stamped.

DUSTLESS ROOMS

On all Laboratory, Library, Museum, School, &c. Floors and Linoleums of every description

USE **FLORIGENE**

(A Regd. Name suggested by Floor-Hygiene).

VERY EARLY in EACH VACATION for Best Results.

It is IMPORTANT TO NOTE that ONE APPLICATION of "Florigene" ALLAYS the DUST and DIRT for 2 to 12 months, according to traffic, not only during each Sweeping (without Sprinkling of any kind), but also throughout all the intervening periods which is even of greater hygienic importance.

These sanitary and labour-saving advantages are NOT attained by sweeping-powders or any other method.

Send for particulars, Medical Reports, and Testimonials to

The "DUST-ALLAYER" Co.

165, Queen Victoria Street, London, E.C.

Contractors to Admiralty, War Office, H.M. Office of Works, L.C.C., &c.

Reprinted from "Knowledge," May, 1911, issue.

A BIRD'S-EYE VIEW OF THE HISTORY OF ASTRONOMY

(WITH FOLDING PLATE).

By W. ALFRED PARR.

PRICE SIXPENCE.

London:

Knowledge Publishing Company, Limited,

Avenue Chambers, Bloomsbury Square, W.C.

Royal Naval Division

PUBLIC SCHOOL BATTALION.

THE ADMIRALTY have given official permission for raising a Battalion of 1,000 men, which will be strictly limited to Public School or University Men, and who will serve together as a Unit.

Training is now going forward.

SERVICE

For the period of the

WAR.

Military Training.

Ages 18—35.

Applicants desiring to enrol should apply at once to

ROYAL NAVAL DIVISION,

6, 7, 8 Old Bond Street, London, W.

Phone: Regen 5515.

GOD SAVE THE KING.

THE

English Mechanic

AND

WORLD OF SCIENCE

Commences with Volume CI its Second Century.

For fifty years it has steadily and continuously broadened the bounds of its influence, and yearly added to the ranks of its thousands of voluntary helpers. We ask to-day, not for conscription, but for universal voluntary service in the task of enlisting the young in the service of science. It is no duty of ours to discuss whether we were ready as a nation for the great struggle in which the British Empire is engaged; but it is no secret that, after a generation of universal elementary education, the majority of our countrymen grow into manhood and womanhood ill equipped for the industrial struggle with their competitors of better-trained nations, and content to seek recreation in vicarious athletics and the unedifying, but exciting, "popular" literature of the time. Of hundreds of thousands of these it is the bare truth to say the fault is not theirs, but that of their teachers. If youth were but led judiciously, and without pedantry, to the realisation of the pleasures of science, aptitude and inclination would attract yearly increasing thousands to the profitable utilisation thereof in manhood. One proof that this is so is the eagerness with which the English Mechanic is read in schools where the teachers have familiarised the children with its contents. Will more teachers make The English Mechanic and World of Science their school book? If so, thousands of men and women who will read its pages fifty years hence will gratefully remember them.

A Specimen Copy will be sent free to any address on request.

ENGLISH MECHANIC,

5, EFFINGHAM HOUSE,

ARUNDEL STREET, STRAND, LONDON, W.C.

CONTENTS.

PAGE.

CHAPTERS IN SPECTRUM ANALYSIS. I (*continued*). *By W. Marshall Watts, D.Sc.* 97

ON THE FORMATION OF HAIR PIGMENT. *By H. Onslow.* 101

DUST. *By William Swaine.* 103

THE MAKING OF GUN-FLINTS. *By Wilfred Mark Webb, F.L.S.* 106

SOLAR DISTURBANCES DURING FEBRUARY, 1915. *By Frank C. Dennett.* 111

NOTES.—

Astronomy. *By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.* 112

Botany. *By Professor F. Cavers, D.Sc., F.L.S.* 112

Chemistry. *By C. Ainsworth Mitchell, B.A., F.I.C.* 113

Geography. ... ... *By A. Scott, M.A., B.Sc.* 113

Geology. *By G. W. Tyrrell, A.R.C.Sc., F.G.S.* 114

PAGE.

NOTES (*continued*):—

Meteorology. *By William Marriott, F.R.Met.Soc.* 114

Microscopy. ... *By J. E. Barnard. F.R.M.S.* 115

Photography. ... ... *By Edgar Senior.* 116

Physics. *By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.* 117

Radio-Activity. *By Alexander Fleck, B.Sc.* 118

Zoölogy. *By Professor J. Arthur Thomson, M.A., LL.D.* 119

NUMBER OF SPORES IN A MYXOMYCETE. *By W. B. Grove, M.A.* 120

THE FACE OF THE SKY FOR MAY. *By A. C. D. Crommelin. B.A., D.Sc., F.R.A.S.* 121

POLLARDS. 122

STONYHURST COLLEGE OBSERVATORY. *By Frank C. Dennett.* 125

REVIEWS. 125

NOTICES. 128

NOTICES.

CONTRIBUTIONS.—Every endeavour will be made to return unaccepted contributions which are accompanied by a stamped addressed envelope, but the Editors will accept no responsibility for accidental loss.

ADVERTISEMENTS.—All matters relating to advertisements should be sent to the Advertisement Manager.

BUSINESS.—All other business letters should be addressed to the Secretary, and all remittances made payable to the order of "KNOWLEDGE" Publishing Company, Limited.

SUBSCRIPTIONS.—"KNOWLEDGE" will be sent post free, for a year, to any part of the world for 15/-. Single copies will be posted for 1/3.

BOUND VOLUMES.—Recent Yearly Cloth-Bound Volumes may be obtained at 15/- net, post free within the United Kingdom.

BINDING CASES in Blue Cloth with gilt lettering, down to 1908, 1/6 net each, by post 1/9; 1909 and after, 1/9 net each, by post 2/-.

BACK NUMBERS.—1885 to 1895, 2/- each; 1896 to 1905, 1/6 each; 1906 and after, 1/- each (except January to April, 1910, 2/-) Issues prior to 1885 are out of print.

LANTERN SLIDES of many of the illustrations may be obtained from Messrs. NEWTON & Co., 37, King Street, Covent Garden, London, W.C.

OFFICES: AVENUE CHAMBERS, BLOOMSBURY SQUARE, LONDON, W.C.

Telephones:—(Office) 4060 *City.* *and (Editorial)* 642 *Ealing*

IONIUM

Permanent Alpha Ray Activity

RADIO-LEAD

MESO-THORIUM

Glew's Scintilloscopes charged with IONIUM, RADIUM, MESO-THORIUM, or ACTINIUM, **7/6** each.

Scintilloscopes showing Double Scintillations Thorium "A," **15/-** each.

F. HARRISON GLEW,

156, CLAPHAM ROAD, LONDON, S.W.

Advertisement Rates.

	£	s.	d.
Whole Page	6	6	0
Half Page	3	5	0
Quarter Page	1	15	0
One-Eighth Page	0	18	6
One-Sixteenth Page	0	10	0
Per Inch, Narrow Column	0	7	0
Half " " "	0	4	0

NET.

DISCOUNTS FOR SERIES OF INSERTIONS AND RATES FOR SPECIAL POSITIONS, WHEN VACANT, ON APPLICATION TO

THE ADVERTISEMENT MANAGER,

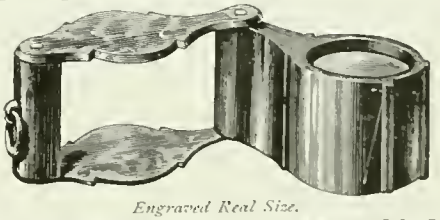
KNOWLEDGE OFFICE,

AVENUE CHAMBERS, BLOOMSBURY SQUARE, LONDON, W.C.

"The Naturalist's Companion."

BROWNING'S PLATYSCOPIC LENS

With Larger Angles, Increased Field, and Improved Definition.



Engraved Real Size.

AN ACHROMATIC COMBINATION

Combining the Definition of a Microscope with the Portability of a Pocket Lens.

"If you carry a small Platyscopic Pocket Lens (which every observer of Nature ought to do)."—GRANT ALLEN, in *Knowledge.*

"I have long carried one of these instruments and found it invaluable."—JOHN T. CARRINGTON, Editor of *Science Gossip.*

The Platyscopic Lens is invaluable for low-power examination of POND LIFE, BOTANICAL, GEOLOGICAL, ENTOMOLOGICAL, and other objects, as it focusses about three times as far from the object as the Coddington Lens, and has a field unequalled for flatness, allowing opaque objects to be examined easily.

It is made in four degrees of power, magnifying respectively 10, 15, 20, and 30 diams.; the lowest power, having the largest field, is the best adapted for general use.

Mounted in Tortoiseshell, magnifying 10, 15, 20, *or* 30 *diameters, either power*	**15s. 0d.**
In Nickelised German Silver, either power ..	**17s. 6d.**
Combinations of any 2 *powers, in Tortoiseshell* ...	**27s. 6d.**
Ditto Ditto in Nickelised German Silver	**32s. 6d.**

ILLUSTRATED DESCRIPTION SENT FREE.

JOHN BROWNING, Manufacturing Optician,

146 STRAND, W.C., and 72 NEW OXFORD STREET, W.C. } **LONDON.**

Estab. 1765. Tel. No.: 7804 Central.

Index of Spectra

NEW SERIES.

Designed to complete and bring up to date the Index of Spectra and previous Appendices.

Appendix V contains Air, Aldebaranium, Aluminium, Alumina, Ammonia, Antimony, Argon, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Caesium, Calcium, Carbon, Cassiopeium, Cerium, Chlorine, **12s. 6d.**

Appendix W contains Chromium, Cobalt, Copper, Dysprosium, Erbium, Europium, Fluorine, and "Additions and Corrections to Appendix V," **12s. 6d.**

The other parts of this work are:

The Index of Spectra bound volume (including Appendix A), **£1 5s.**

Appendix B (Table of corrections to reduce to Rowland's standard, ultra-violet spectra of Co and Ni, etc.), **3s. 6d.**

Appendix C (Spectrum of Iron, telluric lines of solar spectrum, spectrum of Hydrogen), **7s. 6d.**

Appendix D (Arc-spectra of Ga, Li, Na, K, Rb, Cs, Mg, Ca, Zn, Sr, Cd, Ba, Hg, absorption spectrum of Bromine, Arc-spectrum of Alumina), **5s. 6d.**

Appendix E (Spectra of Air, Cu, Ag, An, Al, In, Tl, C, CN, N, Si, ammonia, and Table of reductions to vacuum), **4s. 6d.**

Appendix F (The Arc-spectra of Cr, Sn, Pb, Sb, Bi, flame-spectra of K, Na, Li, Ca, Sr, Ba, etc.), **3s. 6d.**

Appendix G (Rowland's Standard Wave-lengths, Spectra of Hg, He, Cd, etc., and oxy-hydrogen spectra), **5s. 6d.**

Appendix H (The three spectra of Argon, the arc-spectrum of Ti, the spark-spectra of Cu, Ag, and Au), **5s. 6d.**

Appendix I (The arc- and spark-spectra of Co and Ni, and "Index Indicis"), **5s.**

Appendix J (The spark-spectra of Fe and W, and the arc- and spark-spectra of Pt), **8s.**

Appendix K (Spectrum of Chlorine, and the spark-spectrum of Mo) **5s.**

Appendix L (Spectra of Bromine, Gallium and Radium, and the spark-spectrum of Uranium), **7s. 6d.**

Appendix M (The arc-spectra of Mn and V, the spark-spectra of V, Au and Si, and the spectrum of Argon), **6s.**

Appendix N (Flame-spectrum of Radium, infra-red spectra of Alkalies, ultra-violet spectrum of Thorium), **4s.**

Appendix O (Arc-spectrum of Mo, spark-spectra of Ca, Sc, In, Be Li, Tl, K, Cs, Sb, As, Ra), **4s.**

Appendix P (Arc- and spark-spectra of Ruthenium, Yttrium; Line- and Band-spectra of Sulphur), **7s. 6d.**

Appendix Q (Spectra of Neon, Xenon, and Krypton, and a *second* "Index Indicis"), **4s. 6d.**

Appendix R (Spark-spectrum of Cr; Arc- and spark-spectra of Pa, and the Spectra of Polonium and Ex-radio), **5s. 6d.**

Appendix S (Arc- and spark-spectra of Ir Os, and Rh), **10s. 6d.**

Appendix T (Arc- and spark-spectra of Tantalum, Zirconium and Lanthanum), **8s.**

Appendix U (Table of the Stronger Lines of the Elements, arranged according to wave-length), **10s. 6d.**

Appendices B to I inclusive, bound in one volume, price **£2 3s.**

Appendices J to Q „ „ „ „ **£2 8s.**

From "Nature," December 11th, 1913:—

"'Watts' Index of Spectra.'—Yet another series of Appendices to this most valuable compilation of wave-length data has been commenced by the publication of Appendix V."

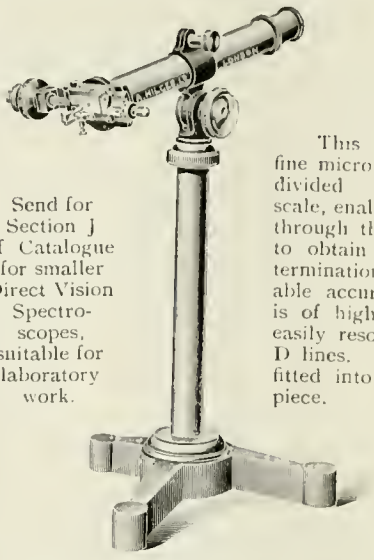
Post free from the Author:

Dr. W. MARSHALL WATTS,

"Shirley," Venner Road, Sydenham, London, S.E.

Direct Vision Spectroscope

8½" LONG.



Send for Section J of Catalogue for smaller Direct Vision Spectroscopes, suitable for laboratory work.

This instrument has a fine micrometer screw with divided drumhead and scale, enabling one to pass through the spectrum and to obtain wave-length determinations with considerable accuracy. The prism is of high dispersion, and easily resolves the sodium D lines. A pointer is also fitted into a positive eye-piece.

Prices: { **Instrument - £9 10 0** / **Stand - - £2 2 0**

DELIVERY FROM STOCK.

ADAM HILGER, Ltd.,

75A, CAMDEN ROAD, LONDON, N.W.

Telegrams: "Sphericity, Camroad, London." Telephone: North 1687.

OHMS

Keep one of our Departments always busy. We manufacture them in the form of

RHEOSTATS

of all types, values, and carrying capacities, from the SMALLEST SLIDER to the LARGEST LOAD or CALIBRATION Set.

BRITISH MADE ONLY

ISENTHAL & Co.

(Department 2)

Denzil Works, Neasden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, and the Postmaster General.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1915.

CHAPTERS IN SPECTRUM ANALYSIS.

By W. MARSHALL WATTS, D. Sc.

I.—Law and Order in Spectra.

A. Line Spectra.

(*Continued from page* 69.)

The absorption spectra of potassium, rubidium, and caesium show long series of regularly arranged pairs of lines similar to those seen in sodium. These three metals are very closely allied in their chemical and physical properties, and their spectra show a most remarkable agreement. In the diagram (see Figure 79) these three spectra are mapped upon a scale of oscillation-frequency—that of caesium at a "height" of 17638, that of rubidium at the "height" of 7301, and that of potassium at the "height" of 1528, as shown by the scale on the left-hand edge of the diagram, these numbers being the squares of the atomic weights: 132·81 for caesium, 85·45 for rubidium, and 39·1 for potassium. The *connecting-lines*, marked $m=3$, $m=4$, $m=5$, and so on, show the exact correspondence of the spectra line for line. Further, the lines joining corresponding points in caesium and potassium pass *almost exactly* through the corresponding points in rubidium.

The principal series in potassium is set forth in the following table, with the wave-lengths calculated from the formulae

$$\text{O.F.} = 35005{\cdot}56 - \frac{109675}{\left(m + {\cdot}293076 - \frac{{\cdot}061356}{m-1}\right)^2}$$

for the less refrangible component, and

$$\text{O.F.} = 35005{\cdot}56 - \frac{109675}{\left(m + {\cdot}296228 - \frac{{\cdot}061628}{m-1}\right)^2}$$

for the more refrangible component of the *pairs* of lines.

Table 18.

The Principal Series in Potassium.

m.	Observed. O.	Calculated. C.	O—C.
2	7699·23	7699·10	+·13
	7665·27	7665·60	−·33
3	4047·38	4047·51	−·13
	4044·32	4044·13	+·19
4	3447·53	3447·59	−·06
	3446·53	3446·56	−·03
5	3217·76	3217·83	−·07
	3217·31	3217·36	−·05
6	3102·37	3102·27	+·10
	3102·15	3102·00	+·15
7	3034·94	3035·09	−·10
		3035·00	
8	2992·47	2992·43	+·03
9	2963·37	2963·53	−·16
10	2942·8	2942·99	−·19
11	2928·0	2927·86	+·14
12	2916·6	2916·38	+·22
13	2907·6	2907·45	+·15
14	2900·4	2900·38	+·02
15	2894·6	2894·67	−·07
16	2889·7	2890·00	−·30
17	2885·9	2886·12	−·22
18	2882·9	2882·87	+·03
19	2880·3	2880·12	+·18
20	2877·9	2877·77	+·13
21	2875·8	2875·75	+·05
22	2874·1	2873·99	+·11
23	2872·5	2872·46	+·04
24	2871·1	2871·12	−·02
25	2870·0	2869·93	+·07

For rubidium the formulae

$$\text{O.F.} = 33688{\cdot}20 - \frac{109675}{\left(m + {\cdot}352806 - \frac{{\cdot}073542}{m-1}\right)^2} \text{ (l.r. line)}$$

$$\text{O.F.} = 33688{\cdot}20 - \frac{109675}{\left(m + {\cdot}365934 - \frac{{\cdot}073868}{m-1}\right)^2} \text{ (m.r. line)}$$

give equally good results, as shown in the following table:

Table 19.

The Principal Series in Rubidium.

m.	Observed.	Calculated.	O—C.
2	7949·04	7949·03	+·01
	7803·17	7803·13	+·04
3	4215·72	4215·72	0
	4201·98	4201·99	−·01
4	3591·74	3591·74	0
	3587·23	3587·22	+·01
5	3350·99	3350·94	+·05
	3348·86	3348·93	−·07
6	3229·26	3229·27	−·01
	3228·18	3228·10	+·08
7	3158·47	3158·39	+·08
	3157·69	3157·67	+·02
8	3112·95	3112·95	0
9	3082·39	3082·34	+·05
10	3060·62	3060·56	+·06
11	3044·33	3044·47	−·14
12	3032·20	3032·25	−·05
13	3022·70	3022·74	−·04
14	3015·16	3015·20	−·04
15	3009·03	3009·11	−·08
16	3004·11	3004·12	−·01
17	2999·96	2999·98	−·02
18	2996·51	2996·51	0
19	2993·52	2993·57	−·05
20	2991·12	2991·06	+·06
21	2988·94	2988·89	+·05
22	2987·01	2987·02	−·01
23	2985·45	2985·38	+·07
24	2984·05	2983·94	+·11
25	2982·68	2982·67	+·01
26	2981·51	2981·53	−·02
27	2980·52	2980·53	−·01
28	2979·62	2979·62	0
29	2978·81	2978·81	0
30	2978·10	2978·08	+·02
31	2977·39	2977·42	−·03

In caesium the formulae

$$\text{O.F.} = 31404{\cdot}6 - \frac{109675}{\left(m + {\cdot}418206 - \frac{{\cdot}09002}{m-1}\right)^2}$$

$$\text{O.F.} = 31404{\cdot}6 - \frac{109675}{\left(m + {\cdot}449975 - \frac{{\cdot}089294}{m-1}\right)^2}$$

give the following results:

Table 20.

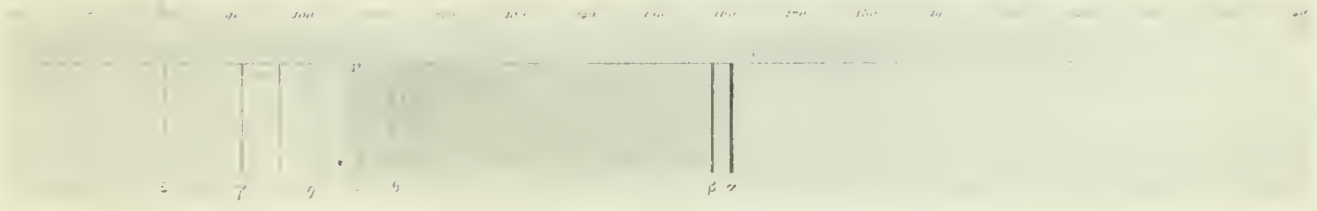
The Principal Series in Caesium.

m.	Observed.	Calculated.	O—C.
2	8949·92	8949·92	0
	8527·72	8527·72	0
3	4593·34	4593·34	0
	4555·44	4555·44	0
4	3888·79	3888·75	+·04
	3876·53	3876·36	+·17
5	3617·56	3617·44	+·13
	3611·67	3611·62	+·05
6	3480·28	3480·19	+·09
	3477·03	3477·13	−·10
7	3400·13	3400·13	0
	3398·27	3398·14	+·13
8	3348·84	3348·93	−·09
	3347·56	3347·68	−·12
9	3314·16	3314·25	−·09
	3313·28	3313·33	−·05
10	3289·25	3289·50	−·25
	3288·68	3288·84	−·16
11	3270·56	3270·72	−·16
12	3256·77	3256·92	−·15
13	3246·02	3246·18	−·16
14	3237·58	3237·65	−·07
15	3230·69	3230·78	−·09
16	3225·11	3225·11	0
17	3220·34	3220·43	−·09
18	3216·45	3216·48	−·03
19	3213·02	3213·11	−·09
20	3210·18	3210·26	−·08
21	3207·78	3207·80	−·02
22	3205·64	3205·66	−·02
23	3203·80	3203·79	+·01
24	3202·13	3202·15	−·02
25	3200·71	3200·70	+·01
26	3199·45	3199·42	+·03
27	3198·25	3198·26	−·01
28	3197·28	3197·23	+·05
29	3196·20	3196·31	−·11
30	3195·42	3195·47	−·05
31	3194·59	3194·72	−·13
32	3193·94	3194·04	−·10

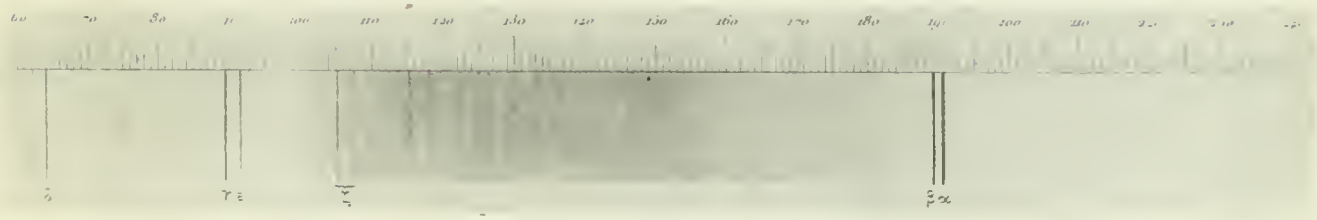
The remarkable similarity between the spectra of the alkali metals was noticed by the early observers. In 1869 Lecoq de Boisbaudran remarks that the spectrum of caesium is, like that of potassium, shifted bodily towards the red. Figure 78 is a photographic reproduction of some of the beautiful drawings of spectra published by de Boisbaudran. The caesium and rubidium lines which he marks α, β are those of the principal series marked $m=3$ in Figure 79 (the diagram does not extend far enough to the right to allow of the red lines of the three elements to be shown, *i.e.*, those for which $m=2$).

That there exists some relationship between the atomic weights of allied elements and their spectra is certain. If we knew the *precise* law of this relationship, the measurement of the wave-lengths of the lines in the spectrum of a new or rare element, particularly of one difficult to obtain in a

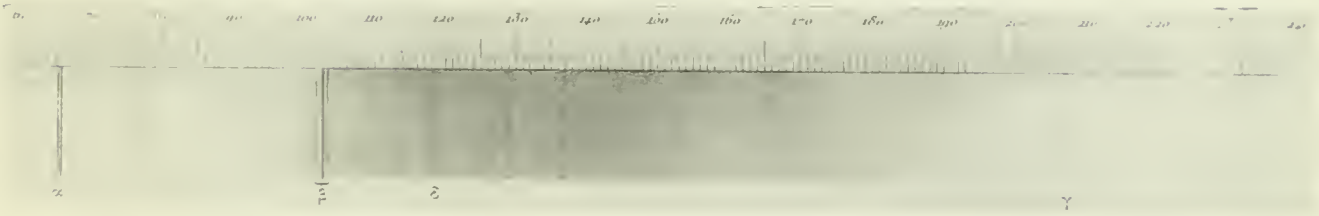
a. Spectrum of the blue flame of illuminating gas.



b. Caesium chloride. Flame spectrum.

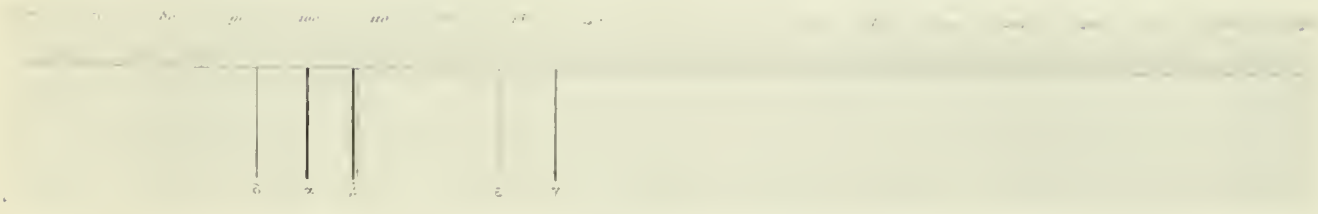


c. Rubidium chloride. Flame spectrum.



d. Potassium chloride. Flame spectrum.

e. Potassium sulphate (fused). Spark spectrum.



f. Sodium sulphate (fused). Spark spectrum.

FIGURE 78.

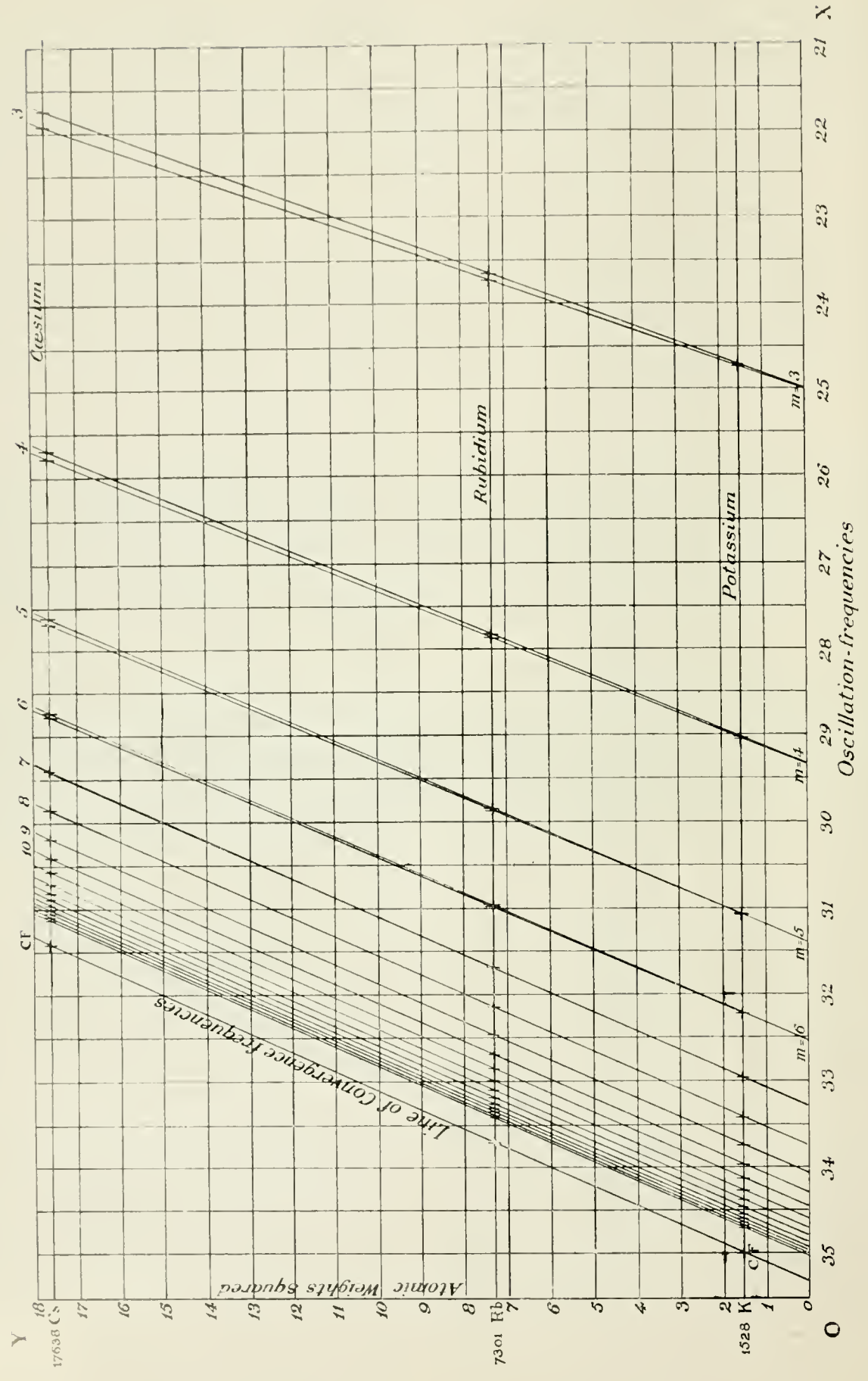

Y
X
O
Atomic Weights Squared
Oscillation-frequencies
Line of Convergence Frequencies
Cæsium
Rubidium
Potassium
m=3
m=4
m=5
m=6
CF
17638 Cs
7301 Rb
1528 K

Figure 79.

state of purity, would afford much more exact data for the determination of the atomic weight than the chemical method. If we consider that even in the case of an element whose atomic weight has been determined repeatedly with the utmost care—say silver or chlorine—the result is not certain to one part in three thousand, whereas the wave-length of a line can be measured with an accuracy of one part in one hundred thousand, we see how important the spectroscopic method might become.

The diagram Figure 79 is drawn to exhibit a relationship between oscillation-frequencies and squares of atomic weights. It will be easily understood that, if this relationship were exact, we could calculate the atomic weight of one of the three elements from those of the other two—say the atomic weight of rubidium—from those of caesium and potassium, 132·81 and 39·10 respectively. Making the calculation for each set of homologous lines $m=3$, $m=4$, $m=5$, and so on, we obtain for the atomic weight of rubidium numbers increasing gradually (but slightly) up to the convergence-frequency, of which a few examples are given.

$m=$ 4	gives the at. wt. of rubidium as		85·047
$m=$ 5	,,	,,	85·575
$m=$ 6	,,	,,	85·943
$m=$ 7	,,	,,	86·060
$m=$ 8	,,	,,	85·814
$m=$ 9	,,	,,	85·830
$m=$10	,,	,,	86·141
$m=$11	,,	,,	86·069

Mean 85·81.

The recognised atomic weight is 85·45.

It will further be remarked that in the diagram the connecting-lines seem to intersect on the line of zero atomic weight; or, in other words, the separations of the pairs of lines are proportional to the squares of atomic weights. Thus for the red pairs we have

	Wave-lengths.	Oscillation-frequencies.	Difference.
Potassium	7699·23	12984·81	57·54
	7665·27	13042·35	
Rubidium	7949·04	12576·74	230·43
	7803·17	12807·17	
Caesium	8949·92	11170·26	553·00
	8527·72	11723·26	

From the proportion $Rb^2 : Cs^2 = 230·43 : 553·00$ we get for rubidium 85·73 when $Cs = 132·81$.

(To be continued.)

ON THE FORMATION OF HAIR PIGMENT.

By H. ONSLOW.

The histological formation of the hairs of certain animals and the condition in which the pigment is present in them were described in an earlier communication.* We must now inquire into the processes involved in the production of this pigment. The earliest investigators were of the opinion that the melanins, or dark pigments of the skin and hair, had their origin in the blood, as is the case with the bile and certain other body pigments. There was, however, little or no evidence on which to base such a theory, except the fact that it was found that the weight of iron contained in the ash of negroes' skin was twice as great as that of the white man's skin, and other equally inconclusive evidence. It is now known that the keratin of the skin and hair contains a certain quantity of iron, which is not, however, a necessary component of the melanin molecule, and has no connection with the iron of haemoglobin. The theory that these pigments were derived from the blood received its death-blow with the discovery that the sap of the Japanese lacquer-tree, described by Yoshida, contained a ferment capable of oxidising a certain phenolic substance or chromogen to the black lustrous pigment which composes the surface of Oriental lacquer. Shortly afterwards, the further discovery that this oxidising ferment was widely distributed throughout both the vegetable and animal kingdoms served to form the foundation of the modern oxydase theory of pigment formation. Many of these ferments, called laccases, have the power of oxidising some phenolic substances, especially those containing several hydroxyl groups, to products varying in colour from yellow to black. Others, the so-called tyrosinases, oxidise solutions of the amino-acid tyrosine, as well as many polypeptides, containing tyrosine, which are changed through red to violet, and yield finally a black precipitate. A plausible theory for the production of many animal pigments is suggested by the fact that phenols (*e.g.*, p-cresol) in the presence of amino compounds may be made to show an almost infinite variety of colours by suitably varying the phenol and amino components.

In the vegetable kingdom these ferments are found in a number of fungi, in potatoes, and in many roots. Among animals they are found in the body-filling of meal-worms, in the larvae of many insects, and in the pigment sac of the cuttle-fish, where they give rise to sepia. Among vertebrates, also, both tyrosinase and tyrosine are found in

* "Knowledge," Volume XXXVII, page 161 (May, 1914).

melanotic tumours, and tyrosinase alone in the skin of young or foetal rabbits.*

The discovery of this wide distribution of tyrosinases resulted in the formulation of the now commonly accepted theory that the pigments of the hair, skin, and scales are in a great many cases produced by the action of an oxydase upon some chromogenic substance. It is possible that this chromogenic substance, which is of an aromatic nature, must be split off from the protein molecule by a proteolytic enzyme before it can be oxidised.

Further investigations have suggested that an oxydase is of a dual nature, its two constituents being a peroxide and a peroxydase. The peroxide (A_2O_2) combines with the peroxydase (B) to form an unstable compound (A_2BO_2). This immediately breaks down to yield :

(i) An atom of " active " oxygen, O.
(ii) The peroxydase, B.
(iii) The compound A_2O.

The chromogen is oxidised to the pigment by the " active " oxygen, whilst the compound A_2O is reconverted by atmospheric oxygen to the peroxide A_2O_2, so that the cycle can be repeated indefinitely.

The isolation of the melanins and the determination of the constitution of the melanin molecule has presented a problem of extraordinary difficulty to the organic chemist, and even now a satisfactory solution has not been obtained. The reasons for this are chiefly the difficulty of obtaining sufficient material, or of separating it from the keratin of the skin and hair which usually surrounds it, and the lack of strong enough reägents to dissolve the keratin substance without altering the melanin molecule. Attempts have been made to obtain melanin from many sources, such as the skin of negroes, human and horse hair, sarcomatous livers, and the choroid coat of eyes ; but except in the last two cases the melanin has been profoundly altered in the process of extraction. Lately, however, in America, a pigment has been obtained by the long-continued action of very dilute alkalies upon black wool in a form which evidently resembles more closely the naturally occurring pigment than any described hitherto. In this form it dissolves, not only in alkali, but also in dilute acid, and behaves in many other ways like a protein substance, or a substance which is chemically combined with a protein.

The investigation of the natural pigments was originated by the discovery of the black artificial humins which occur as a cleavage residue during the acid hydrolysis of proteins. Recently another humin has been studied, namely, the product of the action of tyrosinase upon tyrosine, and tyrosine itself has been oxidised by strong hydrochloric acid to a black substance. These artificial products seem to bear a fairly close relationship to the natural melanins, though it is difficult to determine their constitution accurately. In spite of the fact that tyrosine so easily yields black products, it is not necessarily the mother-substance of the natural pigments, as has so often been suggested, for there is no reason why tryptophane, or some other cyclic compound, should not function equally well.

It may be seen from what has been said that the black pigments have received the exclusive attention of investigators, and that the other hair pigments, of which yellow would seem to promise most opportunity for research, have been entirely neglected.† It might be thought that this yellow substance is connected with the well-known urinary pigment, urochrome, or else with those other body pigments called lipochromes, which give to fat butter and blood serum their yellow colour, and which have lately been shown to be identical in many cases with the crystalline vegetable pigments, carotin and xanthophyll. It does not, however, seem to resemble either of these, and indeed it is difficult to know whether a true yellow pigment really exists, or whether the effect is produced by the density with which the black pigment has been deposited. For by suitably diluting a solution of melanin, which is deep brown by transmitted light and black by reflected light, it is possible to obtain solutions of various shades of brown, or even, on extreme dilution, a bright yellow. The black, chocolate, and yellow pigments show very similar solubilities in both acid and alkali ; and, moreover, when equal weights of these three pigments, dissolved in equal volumes of dilute alkali, are compared by means of a colorimeter the difference in the depths of the colours is insignificant.

* It seems probable that only the peroxydase constituent of the tyrosinase can be extracted in this case, since the addition of hydrogen-peroxide is necessary for the proper oxidation and development of the colour *in vitro*.

† The beautiful yellow pigment of our common brimstone butterfly has been shown to be a derivative of uric acid, while the white pigment of cabbage butterflies is nothing else but uric acid itself. The uric-acid pigments are confined to the Pieridae, and are not present in the wings of the Heliconiidae, which are mimicked so closely by the Pieridae (genus *Leptalis*).

DUST.

By WILLIAM SWAINE.

In a certain sense we all know what dust is—something very plentiful and often extremely annoying. The housekeeper is plagued very much with it. She sweeps it off the mantelpiece with her cloth, but whither does it go? In most cases either back again to its old place or on to another piece of furniture which very probably has only just been swept clear of it. Since dust is so plentiful one ought to become extremely familiar with what it is, what it does, what are its advantages and disadvantages, and the reason for its being where it is. But it is very questionable whether we give it very much thought.

Dust is found over land and sea, but it is obvious that dust must be more plentiful over the land. However, Dr. J. Aitken, of Glasgow, has devoted a large part of his time to the study of its prevalence. In 1891 he devised an instrument, called a "dust counter," by means of which he has detected and counted particles of dust. The following figures are only very approximate :—

Number of Dust Parts per c.c.	Place.
2000 600 500-200	Atlantic Ocean Pacific Ocean Indian Ocean
As much as 150,000	London, Edinburgh, etc.
14,000-100	Ben Nevis

Measurements on Ben Nevis have revealed a diurnal range, maximum in the afternoon (ascending air currents), and minimum in the early morning. Approximately for every three thousand feet ascent the amount becomes four-fifths of the number at the lower level.

How many dust particles must an inveterate smoker puff out in a lifetime when with one puff he expels 4,000,000,000, and what must be the number from the exhaust of a petrol motor?

The number of dust particles has lately increased near country roads owing to the great increase in motor traffic—as we all know to our cost. Tuberculosis has been noticed to have become more prevalent amongst cattle grazing near a dusty highway, and in fruit-growing districts the dust clogs the pores of the leaves, causing thereby loss to the gardener.

The causes of excessive dust formation on the roads are chemical, physical, and mechanical, and to-day methods of prevention are of two classes—(*a*) sanitary removal by sprinkling with water or some suitable hygroscopic solid, and (*b*) tar-spraying the roads. The latter method is now largely adopted. Tar-spraying, however, has its disadvantages. Thus in a recent paper we read of the Carmarthenshire Main Roads Committee considering a claim for damages from a bee-keeper whose stock, it was maintained, had all died owing to the tar-spraying of the adjacent road. Fish in streams have been poisoned, thus causing an inquiry into the least injurious tar for tar-spraying purposes. Authorities appear to agree in their ideas of a future road. Hubbard suggests "a bituminous concrete surface with a cement concrete base," and this has been tried in the United States with reasonable success. Sir John Macdonald suggests a carpeted road, the carpet to consist of bitumen and laid on a surface of stone held together by some pitchy substance.

The main causes in the upraising of dust by motors, and so on, are (*a*) cyclonic air currents produced in the rear, (*b*) the great tractive force of the hind wheels, together with (*c*) their uneven turning motion.

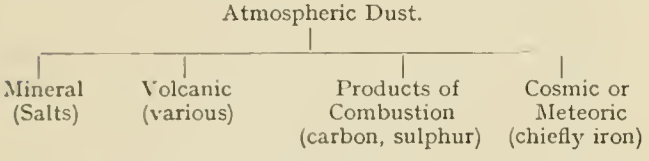
Dusts are either harmless or harmful. The dust which flies about the rooms in bakeries and wood turneries is harmless and, according to some people, fattening. Coal dust and that which hangs about the mills of Lancashire and Yorkshire are more or less harmful. According to certain authorities the coal miner is least troubled with lung diseases. Tin miners, quarrymen, potters, stonemasons, and filemakers are, in decreasing order of magnitude, subject to respiratory diseases. Workers in most chemical works are considerably affected by the corrosive action of the chemical dusts. A visit to a soap works reveals the precautions taken by workers near caustic tanks. Even people outside the works have uncomfortable experiences with floating particles of caustic. Then, again, it is only recently that we have had legislation for the improvement of the conditions for the phosphorus worker. Even now "phossy jaw" is not extinct at these works.

In 1868 Tyndall wanted to have air freed from dust as far as possible in order to carry on some delicate experiments. This led him to investigate the nature of dust. He found that if the air in a chamber were kept still, the dust settled and could be received as it settled by some suitable liquid, *e.g.*, glycerine. But it was not freed from dust. Hence he adopted the plan of passing air over a red-hot spiral of platinum wire contained in a tube. This was the purest he obtained. Finding in 1878

that no fermentation took place in his dust-freed air, knowing that fermentation was caused by germs, he arrived at the conclusion that there was some connection between dust and germs. Nowadays we know that what is usually called dust is really multitudes of microbes adhering to genuine dust. It was to Pasteur's credit that the "germ theory" of disease was discovered, and with the introduction of Listerism it has been asserted that "more human lives have been saved than the wars of the last century have sacrificed." The core of Listerism is the use of the carbolic spray with which a wound and the neighbouring air are dosed, thus killing any fatal microbes. Now microbes cannot live in fresh air and sunlight, and thus doctors advocate a combination of these two as a preventive. Again, the number of microbes varies directly as the number of dust particles; the smaller the amount of dust the less the number of microbes, and consequently the decrease in pulmonary diseases. What a hotbed of disease must our dustbins be where organic refuse and coal ashes are thrown to decompose together! As has been stated previously, the higher we ascend the smaller the number of dust particles, and consequently we see why mountain air is so beneficial to persons suffering from consumption.

Physiographical Aspect.

Represented as a short genealogical tree :—



Dr. J. Aitken was the first to show that when water vapour condenses in the atmosphere it always does so on some nucleus, *e.g.*, dust particles. His dust counter employs this principle. These are not, however, the only agency. Mr. C. T. R. Wilson has shown that air which is free from dust, but ionised, is capable of having water vapour condensed in it. Very probably phenomena such as fogs, clouds, mist, or rain are due to both these influences, dust being plentiful and ionisation caused by the radio-active elements present in the atmosphere, and by sunlight. More recently Dr. Aitken has offered an explanation of fog. If sulphur dioxide be exposed to a strong beam of white light it decomposes, slowly producing a yellow fog of sulphur. Now sulphur dioxide issues forth with other products of combustion from the mouths of chimneys. With the action of sunlight, and a little moisture in the form of water vapour being present, a fog is produced. The characteristics of the London fog are easily explained by this.

The magnificent sunsets which can be seen in different parts of the Earth, and the reddish colour at both dawn and twilight, are due directly to the presence of dust particles and water vapour. In the morning and evening the light from the Sun has to travel through the greatest thickness of air and dust, and since the blue rays are more easily scattered than the red we have the familiar gradation of spectral tints seen at these times. Occasionally there is a second sunset, which is a reflection in the clouds of a more brilliant primary one. These primary and reflected sunsets were much in evidence whilst the Krakatoa dust (autumn, 1883) was spread in a layer about fifteen miles above the surface of the Earth in a broad belt about the Tropics, lasting an hour or two after the real sunset. The "Bishop's Ring" was the name given to the coronae which were formed by the Sun shining through the dust. These coronae were an outer edging to the Sun's disc, blue on the inside, passing through the various colours of the spectrum, the outermost being red. The sunsets at that time were unusually vivid, and the story runs of an American fire brigade setting out to put out an alleged fire at a neighbouring village from which the glow appeared to come. But the Krakatoa eruption is not the only instance. After the Messina disturbance a few years ago the sunsets attracted people's attention, and it was noticed in meteorological circles that our climatal conditions suffered a change. In 1783 volcanic dust (traced afterwards from Skaptar Jokul, Iceland) descended on the Orkneys and Shetlands and North Scotland, ruining crops. In this way the dust was carried a distance of over six hundred miles. Coseguina (Nicaragua), a volcano, in 1835 threw out enough dust to cause utter darkness for thirty-five miles radius, and which, when it fell, was ten feet deep. In four days an upper aërial current carried some dust seven hundred miles. So-called "mud lavas" are really the extremely fine volcanic dusts gathered and mixed by the water, belching forth out of the crater, and often doing more damage than a true lava stream.

Cosmic dust is formed by the disintegration of meteorites owing to friction (they travel from twenty-five to forty miles per second) with our atmosphere. The luminosity of shooting stars is due to the rapid combustion of the meteoric dust in the train of a meteorite.

The presence of sodium salts in the air is easily demonstrated by brushing the dust from one's clothes into a non-luminous flame. The characteristic yellow of sodium is much in evidence. Very probably the ocean spray accounts for its presence. Salts of copper have been detected in city air, and accounted for by the electric flashes of overhead cables.

With the chemical we arrive at the most interesting, and perhaps the most important, side of dust phenomena. Until recently it was considered that fire-damp was the sole cause of coal-mine explosions, but experience has shown that within the last ten years explosions have occurred more frequently in well-ventilated mines. Thus causes have been traced to coal dust which, in the presence of air, is very explosive. Probably the reason is that oxygen

in a well-ventilated mine is continually absorbed by the fine coal dust, whilst the neighbouring air does not become stale. This combination is very dangerous. Dr. Harger, at Liverpool, consequently suggested "a small reduction in the percentage of oxygen, and the addition of a little carbon dioxide to such an extent as not to be harmful to respiration, and to render coal-dust ignition impossible." He further advised the introduction into the mine atmosphere of flue gases, purified from harmful gases and smoke. "It would," he said, "provide immunity, not only from coal-dust explosion, but from fire-damp explosions, and as regards respiration would be as good as ordinary air, and for people liable to consumption better." But the miner does not relish the idea.

Possible dangers of firing fire-damp, or coal dust, are: (1) Lamps of all descriptions; (2) electric leakage causing a spark; (3) blasting explosives; whilst it is advisable that fire-damp should not accumulate. Professor Thornton has investigated the danger derived from electric sparking. Messrs. Sellars and Campbell, at Manchester, have studied explosions of coal gas and air in the laboratory; but perhaps the most practicable investigations are those employing incombustible dusts as a means of "quenching" any likelihood of the spreading of fire by coal dust. Mr. William Garforth, at Altoft, and Professor Dixon (by Ryalo Commission), at Eskmeals, are diligently pursuing inquiries in this direction. Bicarbonate of soda and stone dust have been found most efficient; but the fact still remains that these mineral irritants, if inhaled, encourage pulmonary diseases. It is possible, however, to minimise this, and consequently this does not constitute a serious objection. Owing to the continual accumulation of coal dust the stone dust, and so on, must also be replenished from time to time. The idea of keeping the inflammable dust constantly wet in order to render it safe is attended with the serious objection that the miner would have to work under very unhealthy conditions. It must be remembered that the dust must be continually swamped to prevent drying up; a state of affairs much worse than before, since spontaneous combustion is rendered more likely, especially if any sulphide be in close proximity.

Referring to dust which accumulates in flour mills and oil-cake works, Dr. Harger said that ordinary flour mills were on much the same plane as powder magazines. To test this in a small way we only need to enter a flour mill where the cleaner is sweeping the floors, and to see the disturbed dust ignite at some burning gas-jet and endeavour to spread over the whole room. Measurements have shown us that flour dust is much more explosive than coal dust. Even bits of iron, when overheated by friction, are capable of inflaming this highly explosive dust, and thus magnetic screens are now employed to attract any stray bits of iron which may be present.

Attempts are being made to utilise coal dust owing to its high calorific value, and it is very probable that it will some day be used to a larger extent. Present-day methods of blowing the dust into furnaces are unsuccessful.

The smoke nuisance dates as far back as Elizabeth, whilst attempts at abatement have been made by J. Watt (1785) and Cutler (1815). The causes are traced to imperfect combustion, due to (*a*) inadequate supply of air, and (*b*) wrong combustion temperature. Smoke in itself is not very harmful, but the sulphuric acid produced from the sulphur in the coal is very injurious, having a very corrosive action, and unfortunately it cannot be eliminated by the various methods adopted for smoke abatement. The study of rain in different places suggests a method of determining qualitatively and quantitatively the constitution of atmospheric pollution. Tests with country and town rains show that town rain is acid, whilst country rain is neutral. Anthracite stoves are a successful attempt at decreasing the smoke nuisance, whilst experiments are being made with liquid fuel and electricity. Perhaps in the future smoke will be a thing of the past, if Sir William Ramsay's dream comes true, in which our coal will be burned underground and electrical energy stored up at the coalfields. At present, however, the housekeeper can help by using gas-stoves, although they are not very healthy.

The factory, especially so in copper smelting, is very wasteful. Taking the case of copper smelting, a large quantity of metal dust, together with arsenic, is thrown out with the smelter smoke, having disastrous effects on the countryside. Long flues have been found to recover a large quantity of metal, but electrical methods are now employed to better advantage.

Sir Oliver Lodge in 1884 showed an experiment at the British Association meeting in Montreal in which smoke was caused to condense and fall in fine particles by electrical means. By a similar process he managed to clear from fog a space of from fifty to sixty yards radius at Liverpool University, the potential employed being one hundred thousand volts, dense fogs being dissipated quicker than light ones. This has been applied recently to smelter smoke, and as much as ninety per cent. of the metal dust can be recovered. The commercial value of dust is only just beginning to be realised. Wool dust, for example, is now being employed as a fertiliser. In the near future will it be possible to collect road dust in order to extract the rubber worn from motor tyres, and for it to be profitable?

To phenomena dependent on dust must be added crystallisation and supersaturation—the former needing its presence, and the latter needing its absence.

And what would our world appear like if there were no dust? Very probably the sky would not have its delicate blue colour, but would be black, with the Sun glaring down on the Earth

without any diffusion, whilst the stars would be visible during both day and night ; and no gloriously tinted sunrise or sunset for the poet or man of science to contemplate. On the other hand, no smoky towns, no dusty highways or furniture, and no fog. But which dusts cause the aesthetic results? Chiefly the volcanic and cosmic—those which we *cannot* help. And which dust is it which causes us so much annoyance, and which is so familiar? That which we *can* help, by altering our roads, our locomotion, our domestic fires, and our factories. However, such is the progress of civilisation, and truly " God made the country, and man made the town."

THE MAKING OF GUN FLINTS.

By WILFRED MARK WEBB, F.L.S.

It is interesting at the present time, when the manufacture of cartridges and shells is of the utmost importance to the nation, to remember that the production of gun-flints still goes quietly on. Thousands are exported every year, particularly to tropical countries, where more primitive methods linger, or are found to be more convenient ; or, again, where the British Government sees to it that modern firearms do not get into the hands of the natives.

There seems little doubt but that the maker of gun-flints, or the flint-knapper, as he is called, is carrying on an industry which has continued unbroken from very early prehistoric times, when man first began to fashion implements of stone. It would appear, nevertheless, at first sight that there is a fallacy somewhere, and that there must have been a very long gap between the dying out of the flint arrowhead and the invention of the flint-lock musket.

This is true ; but it must be remembered that the flint in the guns was put there to produce sparks, and was only an adaptation of the strike-a-lights which all through the ages, and even within the memory of many persons still alive, have been used for the purpose of obtaining fire.

There is, indeed, a considerable family likeness between the flints made for the tinder-box and the prehistoric flint implements which are known as " scrapers " (see Figures 82 and 90).

The work of flint-knapping as it is carried on at Brandon, in Suffolk, is briefly this. The flints are taken out of pits, as surface material is refractory and of little use. The picks used, though now made of iron, show by their shape (see Figure 80) that they have been modelled upon the primitive deer-antler picks which have been found in prehistoric workings. Figure 83 shows the breaking up of the large flints with a heavy hammer into convenient sizes, a process which is called " quartering " (see Figure 84). From the lumps thus made flakes are struck off with a lighter hammer, which are in every way comparable to the flakes struck off by prehistoric man from one stone with another.

It will be seen by looking at the core represented in Figure 85 that it is possible to produce a flake with one ridge running down the middle and two sharp edges, or by removing the whole of one facet and part of the two on either side a flat flake with two sharp edges may be obtained. Several of the latter are shown in Figure 81. In the one of the extreme left hand of the picture the under side of the flake is seen, with the bulb of percussion at the top. This is caused by the blow, and is familiar enough in prehistoric flakes. The second specimen shows the old facet, and the third is a flake which has been cut up with the knapping hammer.

A knapper at work is shown in Figure 88, while an enlarged illustration, to show details of this important part of the work, is given in Figure 86. The knapper holds the flake on the top of a wedge-shaped piece of iron, driven into a block. In front of the iron is a piece of leather, over which the knapping hammer is held. This is a very light tool, nowadays made, as a rule, from an old file, and has thin, square ends. With this hammer it is possible to cut the flake into pieces to form the gun-flints, which are afterwards trimmed round with a few dexterous blows.

To the student of flint implements, who is astounded sometimes to see the minuteness of the flakes which have been removed from the edges of a flint knife or arrowhead, and wonders how the work was done, it may be pointed out that one blow of the knapping hammer may make dozens of these ; and it is safe to surmise that the prehistoric artificer was no less clever than his modern representative, and much of the beauty of finish was obtained by a few well-directed blows, and not by much laborious chipping.

According to the sizes of the flakes, gun-flints of various dimensions can be produced. The largest are for cannon flints, and one of these is seen in Figure 87, which also depicts gun, musket, carbine, and pistol flints.

The photographs from which our illustrations were made were obtained at the works of Mr. Fred Snare at Brandon. Gun-flints are also made in France, and these, as a rule, have one end rounded. Mr. Snare also makes strike-a-lights, for flint and steel are still used instead of matches in some parts of the world, and it may be remembered that during the Boer War many tinder-boxes were sent out to our soldiers in South Africa.

Figure 80. The Pick used for getting Flint, and the various Hammers employed by Flint Knappers.

Figure 81. Flint Flakes entire, cut up, and trimmed to form Gun Flints.

Figure 82.

Prehistoric Scrapers. Modern Strike-a Lights.

Figure 83. Quartering.

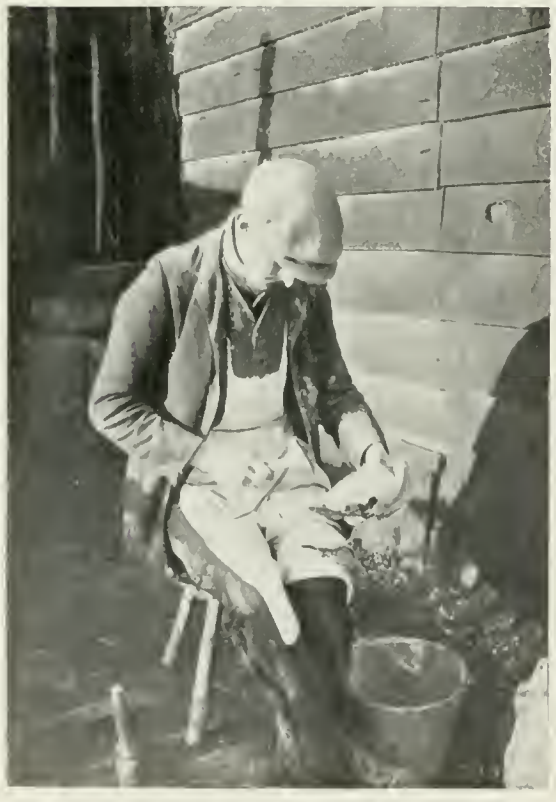


Figure 84. Flaking.

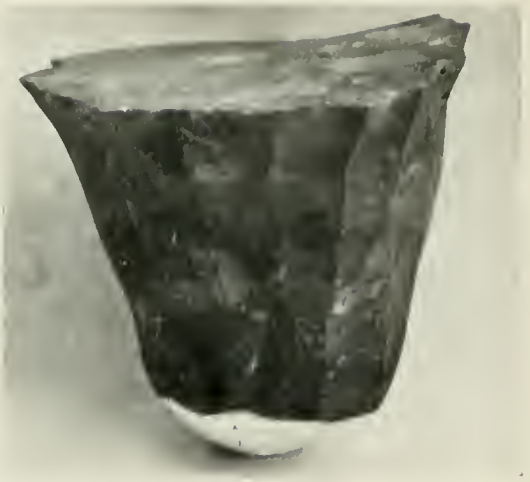


Figure 85. A Core.

Figure 86. Cutting up a Flake.

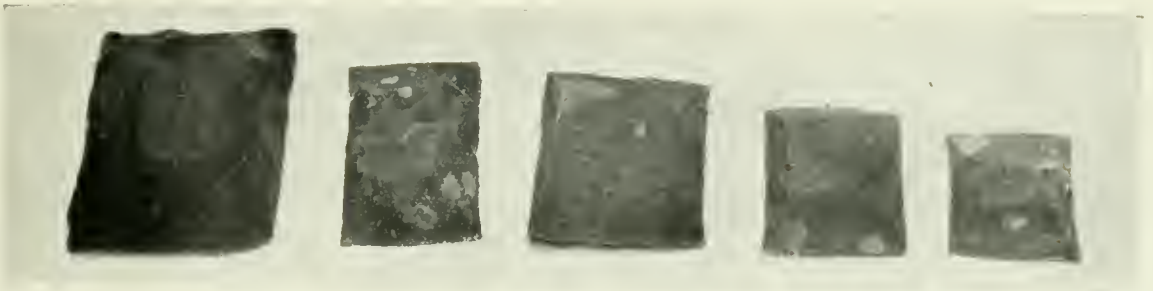


FIGURE 87. Cannon and Gun Flints.

FIGURE 88. Knapping.

FIGURE 89. Flint packed for export.

FIGURE 90. Flint, steel, and fuse.

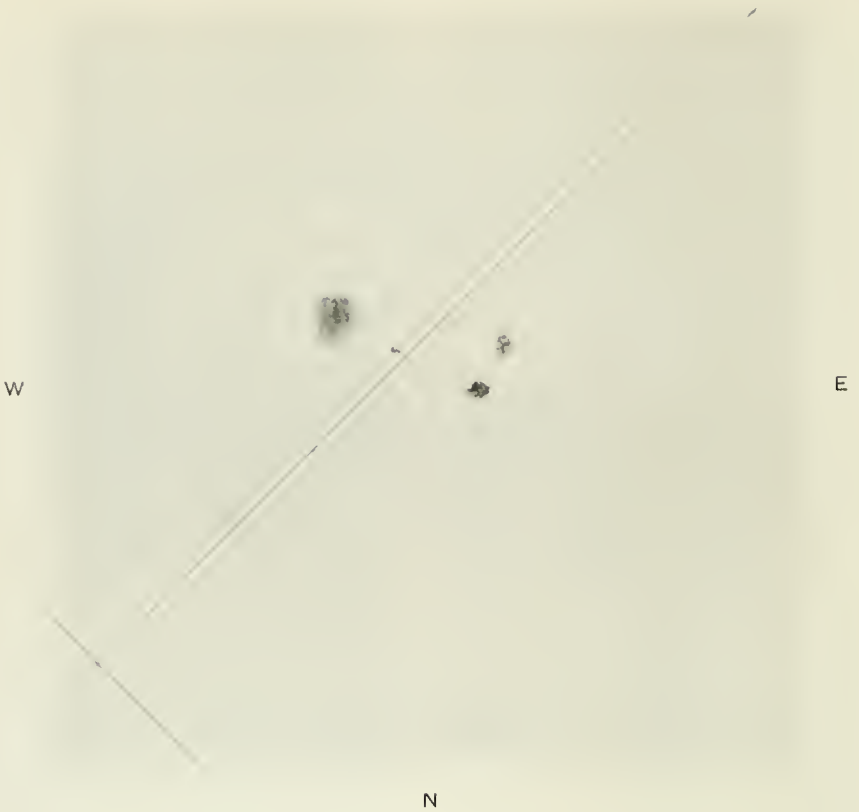


FIGURE 91. 1915, February 25d. 12h. 14.5m.

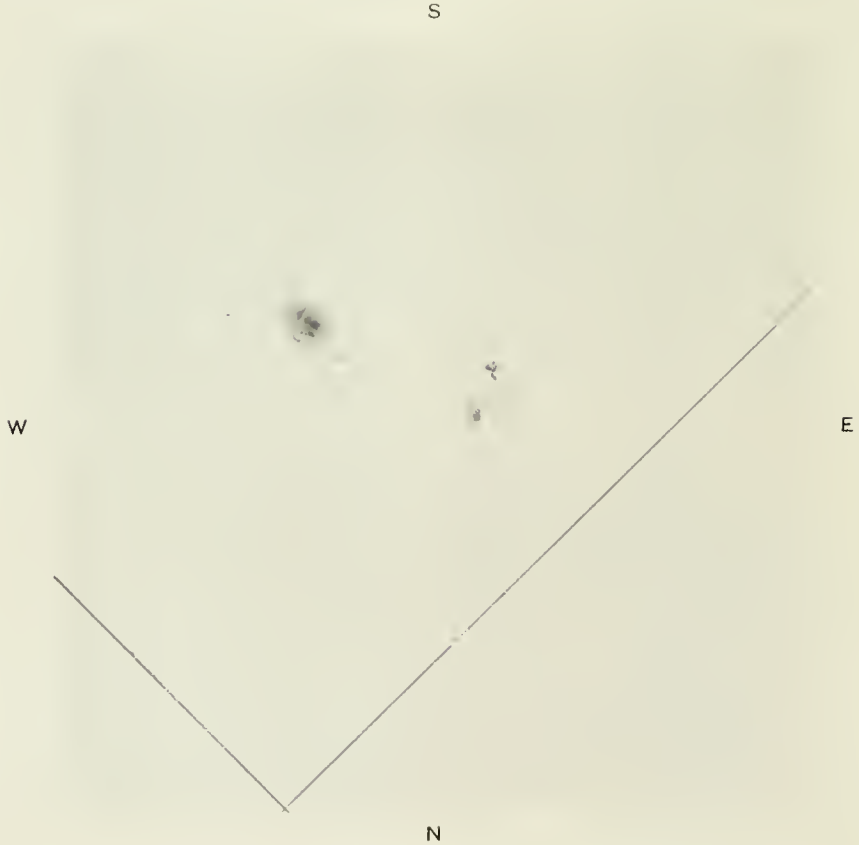


FIGURE 92. 1915, February 26d. 11h. 41m.

A Group of Sun Spots.

From photographs kindly lent by the Astronomer Royal.

SOLAR DISTURBANCES DURING FEBRUARY, 1915.

By FRANK C. DENNETT.

Owing to cloud no observations were possible on five days, February 2nd, 3rd, 7th, 13th, or 17th. On the remaining days the disc never appeared free from spots. Spot disturbances were more in number than in any month since the autumn of 1910. The longitude of the central meridian at noon on February 1st was 42° 52′.

No. 10 of the January list remained visible until February 6th, and therefore reappears upon our chart.

No. 11.—First seen on the 4th, as a somewhat distorted elliptical outbreak, thirty-nine thousand miles in length, increasing until on the 6th it was fifty-six thousand miles. On the 8th only a small two-umbrae spot was visible, but from the 9th until the 12th, when last seen, it was a long group of about eight spotlets and pores.

No. 12.—On the 4th a solitary spotlet, but preceded next day by pores, which on the 6th were arranged as on the diagram. On the 8th and 9th a small leading spotlet with a trail of tiny pores eighty-four thousand miles in length. On the 10th and 11th two small spots were followed by a group of pores. Last seen on the 12th.

No. 13.—Two pores only seen on the morning of the 4th.

No. 14.—A spot fifteen thousand miles in diameter, just round the south-eastern limb on the 5th, having two umbrae from the 8th until the 11th, and a line of three pores on its northern side on the 15th and 16th. Last seen on February 18th.

No. 15.—A fine spot first seen well round the north-eastern limb on the 8th; on the 10th its penumbra had increased to a diameter of over thirty thousand miles, and in the faculae following it two pores had appeared, as shown on the chart. On the 11th part of the penumbra had broken off, and three pores were closely east of it, the more distant ones having disappeared. Only one or two pores seen near it afterwards; last seen at the limb on the 20th.

No. 16.—Three spotlets on the 9th, but on the 10th a train of nine, as shown on the chart, sixty-three thousand miles in length. The numbers were less on the 11th; it was seen until the 14th.

No. 17.—A small spot seen from the 10th till the 12th; there was a pore twenty-five thousand miles following it.

No. 18.—First seen as pores amid brilliant faculae within the south-eastern limb on the 20th and 21st. A curved group on the 23rd, fifty thousand miles in length. By the 25th the leader had grown to sixteen thousand miles in diameter, and was a singular-looking object; the northern trailer was also of peculiar formation; the whole group was altering its appearance rapidly. It was last seen on March 2nd. The Astronomer Royal has kindly supplied two photographs of this group, taken on February 25th and 26th, which are reproduced in Figures 91 and 92. Unfortunately the air was not in favourable condition for photography on the 25th.

No. 19.—Seen on the 21st as a close pair of spotlets. On the 23rd a line of three pores close together, with a smaller one following, the length of the disturbance being forty-two thousand miles. Last seen next day as a solitary pore in a faculic cloud.

No. 20.—When first seen on the 23rd a spot ten thousand miles in diameter, with a pore to the south-east, making the disturbance sixty-four thousand miles in length. This pore was not seen after the 27th; but on March 2nd there were three pores west and south, and on the 3rd others showed south-east as well, but too small to measure. The spot last seen on the 5th, faculae marking the position until the limb was reached on the 8th.

No. 21.—A larger pore, followed by three much smaller ones, seen on the 25th, subject to constant change. Last seen on March 2nd.

No. 22.—Two spotlets, bright-lipped, only seen on the 26th, nearing the south-western limb.

No. 23.—A spot fifteen thousand miles in diameter, just within the limb on the 26th, with fine faculae following it on the 27th. On March 2nd the umbra was crossed by a bright bridge. On the 7th the umbra was of the form of a hook. When last seen, on the 10th it had a smaller companion a little to the south.

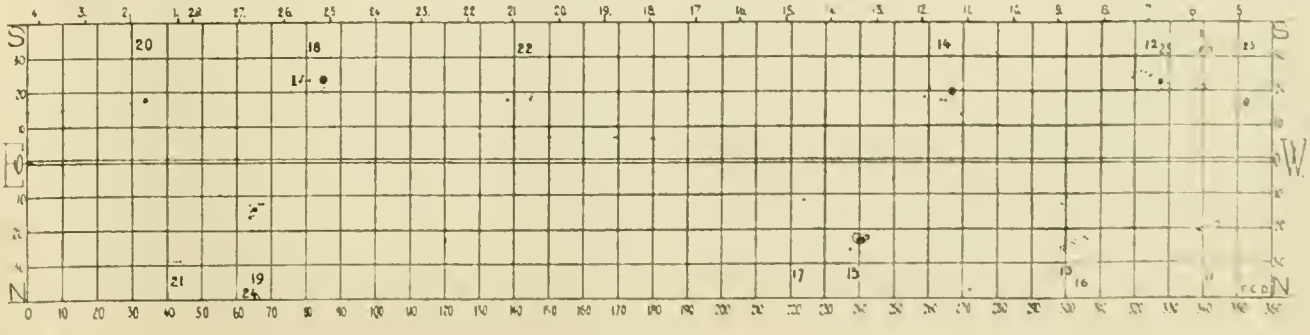
No. 24.—Two spots and two pores between them had broken out close to the central meridian on the 27th. The leader some ten thousand miles in diameter, and the trailer afterwards marked by pores until last seen on March 2nd Its length was forty-three thousand miles.

No. 25.—A spot sixteen thousand miles in diameter came round the limb on February 28th, seen to possess two umbrae on March 6th, last seen on the 10th, only faculae being seen in its place on the 11th.

Faculae were recorded near the west limb on February 20th; north-west on 1st, 6th, 8th, and 24th to 26th; north-east on 5th, 16th, 18th to 20th, 24th, 27th, and 28th; south-west on 4th and 10th; and south-east on 18th to 20th, 25th, and 26th.

Our chart is constructed from the combined observations of Messrs. John McHarg, W. J. Waters, and the writer.

DAY OF FEBRUARY, 1915.



NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE DISTRIBUTION OF ALGOL-STARS IN SPACE.—There is an article on this subject in *The Astrophysical Journal*, December, 1914, by H. N. Russell and H. Shapley. The spectroscope gives the masses, and the type of spectrum also gives the probable surface brilliancy. The absolute magnitude can be deduced with some confidence: this compared with the visual magnitude gives the distance (it is estimated that the uncertainty is not more than twenty-five per cent.). The mean parallax of the ninety stars discussed is $\frac{1}{300}''$, implying a distance of 300 parsecs, or 972 L.Y. The mean of the distances, however, comes out as 2400 L.Y. The method gives 125 L.Y. for Algol, 109 L.Y. for β Aurigae. Direct measures of their parallaxes give 67 L.Y. and 95 L.Y. The agreement is tolerably good. W Ursae Majoris (164 L.Y.) and R Canis Majoris (180 L.Y.) also seem to lie within a measurable distance, but all the others are very remote. They show a considerable concentration towards the galactic plane. Thus seventy-five of the ninety stars lie within 30° of this plane—on uniform distribution there would be only forty-five. The same result holds for the linear distances from the galactic plane. The average distance from this plane is about 450 L.Y. The distances have been calculated on the assumption that there is no absorption of light in space. Evidence is accumulating that the absorption is sensible but small. Using King's value of the absorption, the three greatest distances of stars from the Sun, which before were given as 17200 L.Y., 12400 L.Y., 7900 L.Y., are reduced to 4900, 4200, 3200 respectively. The average distance of all the stars discussed from the galactic plane is now reduced to 280 L.Y.

A similar investigation has been made for the Cepheid variables: this was partly done by Hertzsprung, and has been completed by Russell and Shapley. They prove to be on the average one and a half times the distance of the Algol variables. This is explained by their enormous intrinsic brightness, so that they can be seen at a much greater distance. Both classes of variables agree in indicating that our stellar system is comparatively shallow (perhaps not more than 1000 L.Y. in thickness) towards the galactic poles. The median plane of the stellar system appears to be somewhat to the south of the Sun, perhaps some 50 L.Y. distant from it. This is probably the reason of the greater richness of the southern hemisphere in bright stars.

There are two other articles by H. Shapley in the same magazine. One deals with additional variables in the cluster Messier 3 (in Canes Venatici). S. Bailey had already found at least one hundred and ten variables in it, their periods being all under eighteen hours. He could not investigate the centre of the cluster, as the star images coalesced there. The great separating power of the sixty-inch mirror at Mount Wilson, when used as a Cassegrain, has now permitted the photographic scrutiny of the central region, and Mr. Shapley now announces at least twenty-three new variables within a minute of arc of the centre. The brightest maximum of these new variables is magnitude 14·3, the faintest minimum is magnitude 17·4. In some cases the range of variation is half a magnitude; in others nearly two magnitudes.

Mr. Shapley also discusses Cepheid variables, showing what grave difficulties there are in the way of explaining these by any hypothetical arrangement of pairs of stars. The conclusion is that they are real pulsations in single stars of ellipsoidal figure, either periodic rushes of heated gases from the interior or periodic ebbs and flows of heat, causing the spectral type of the surface to fluctuate.

Mr. H. Shapley also writes in No. 86 of *The Contributions of Mount Wilson Observatory* on the effect of the darkening near the limb in Algol stars. It is well known that the disc of our Sun is much less luminous at the edges than in the centre. The effect is probably less in Sirian than in Solar stars, but it would still be sensible. In the Algol system neglect of this darkening makes the bright star the smaller, but taking it into account the diameters may be equal. The supposed third star which causes a perturbation with period of 1·9 years is also discussed. Its light may amount to one-quarter of that of the whole system, but not more than this.

MELLISH'S COMET.—The orbit of this comet has been deduced by Messrs. Andersen and Fischer, of Copenhagen.

Perihelion	1915, July,	25·109	Berlin M.T.
		° ′	
Arc from Node to Perihelion ...		239 13	
Ascending Node		75 28	
Inclination		51 51	
Log. perihelion distance ...		0·0747	

Ephemeris for Berlin midnight :—

	R.A.	S. Dec.	Log. r.	Log Δ.	Magnitude.
	h. m. s.	° ′			
April 10 ...	18 14 8	3 7	0·2952	0·1635	8·1
,, 26 ...	18 31 18	7 39	0·2555	0·0455	7·4
May 12 ...	18 47 50	16 39	0·2138	9·9013	6·4
,, 28 ...	19 6 25	35 39	0·1715	9·7428	5·4
June 13 ...	19 49 13	68 53	0·1314	9·6604	4·9
,, 29 ...	5 28 56	78 58	0·0983	9·7365	5·0
July 15 ...	6 31 33	63 11	0·0782	9·8527	5·4
,, 31 ...	6 40 55	55 4	0·0763	9·9432	5·9
Aug. 16 ...	6 40 54	50 42	0·0930	0·0036	6·4

The comet will be visible in England till the middle of May, by which time it will probably be faintly visible to the naked eye. The brightness in June and July will probably be greater than that given above, which takes no account of the physical brightening that usually takes place on approach to perihelion. It is hoped that our readers in the southern hemisphere will be able to obtain satisfactory observations.

The recovery of Metcalf's Periodic Comet, recently announced in "Knowledge," proved to be an error. The object observed was the asteroid Lampetia.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

INDIVIDUALITY OF THE CHROMOSOMES IN PLANT NUCLEI.—A melancholy interest attaches to a recently published paper by Sharp (*La Cellule*, Volume XXIX), which represents one of the last pieces of biological research done in the University of Louvain before the destruction of that town by the Germans. It deals with the much discussed question of the individuality of the chromosomes of the nucleus, a subject which has during recent years received a large amount of study at the Louvain laboratory by Grégoire and his pupils, who have maintained that the chromosomes retain their individuality throughout the nuclear divisions that occur in the life of the organism, and are not fused together permanently when the nucleus goes into the resting condition between its divisions. Sharp claims that in many cases, in the cells of the Broad Bean plant which he investigated, the chromosomes can be identified even in the resting nucleus, and that some of the stages leading up to the splitting of the chromosomes have been misinterpreted by previous investigators, who have also overlooked important stages. According to Sharp, the actual splitting takes place at a later

stage than has been supposed ; and, if his observations are correct, they strongly support the theory of the individuality of the chromosome—a point of considerable importance in connection with questions of heredity, since it is generally agreed that hereditary qualities are carried by the chromosomes, while various questions in inheritance depend upon the question whether the chromosomes do or do not retain their individuality.

BIOLOGY OF *FEGATELLA* (*CONOCEPHALUM*).—It has been shown by several writers that *Marchantia*, *Fegatella*, and some other members of the *Marchantia* family of Liverworts are capable of growing in water or in saturated air and in extremely feeble light, and that under these conditions the thallus structure is greatly simplified. The characteristic air-chambers, containing green assimilating filaments, become reduced in extent and simplified in structure in the branches formed in such wet and dark conditions, and the chambers may be absent altogether, the whole thallus also becoming longer and narrower, though chlorophyll is still formed. Miss Maybrook (*New Phytologist*, Volume XIII) has studied the modifications in the thallus of plants of *Fegatella* (*Conocephalum*) *conica*, a common Liverwort found chiefly beside streams and in other moist places. Her plants were collected from a small cavern in a hedge-bank, and she has worked out, in a very interesting manner, the relation between the structure of plants growing in different light intensities. She concludes from her observations that the absence of air-chambers from the plants found in the wettest and darkest positions is due to the combined effects of darkness and moisture, since in plants growing in decreased intensities of light there is a gradual decrease in the number of chambers per unit of thallus surface and in the size of these chambers. The internal structure of the thallus shows interesting deviations in structure ; for instance, diminished length of the curious beak-like cells which normally terminate the assimilating filaments. The final disappearance of the chambers is apparently dependent upon the moisture factor, for only in those plants showing marked adaptation to a moist habitat were the chambers totally undeveloped.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A.(OXON), F.I.C.

FLUORINE IN MINERAL WATERS.—Recent investigations of MM. Gautier and Clausmann (*Bull. Soc. Chim. de France*, 1914, No. 15) have shown that all mineral waters contain fluorine, the proportion being greatest in waters of volcanic origin. Thermal alkali bicarbonate waters are particularly rich in the element, although the proportion does not appear to depend upon the temperature. Speaking generally, mineral waters of the same kind show an increase of fluorine accompanying a rise in the total salts. In the case of calcium sulphate waters, whatever their origin, the amount of fluorine is about two milligrammes, while sea water contains about three milligrammes per litre, the proportion varying slightly in different places and at different depths.

THE COLOUR OF METALS.—Various facts in support of the theory that all metals are naturally of the colour of silver are given by Dr. L. Martiouchek in a Russian chemical journal, and his communication is abstracted in the *Bulletin, Société Chimique* (1914, Volume XVI, page 751). The yellow tint of certain metals, such as calcium, has been found to be due to the presence of traces of impurities, the pure metal being silvery white. Heine has also shown that when copper is specially purified it becomes of a paler tint, the red colour being apparently the result of oxidation caused by the presence of lead oxide. Moreover, the metals potassium, sodium, and rubidium are of a yellow colour when obtained by reducing their chlorides with calcium in the presence of air. In this case the yellow tint is due to the nitrogen, and not to the oxygen, in the air.

POTASH FROM HEDGE CLIPPINGS.—Mr. E. J. Russell calls attention in the *Journal, Board of Agriculture* (1914, Volume XXI, page 694) to the high proportion of potash contained in the ash of bonfires of hedge clippings, weeds, and the like. Samples contained about eleven per cent. of potash (K_2O), or nearly as much as kainite, which contains about 12·5 per cent. Hence the ash obtained in normal processes of the form would be worth about forty shillings per ton in normal times, and much more under the present conditions. It is pointed out, however, that precautions must be taken to protect the ash from the rain, since the potassium salts in the ash are readily soluble in water. For example, the potash in a heap of ash was reduced by fifty per cent. after a single night of moderate rain. It is calculated that the hedges from a twenty-acre field would yield an amount of ash equivalent to nearly two hundredweight of kainite, and that the labour of obtaining and burning the clippings would amount to threepence to eightpence per pound of ash. Hence the potash in this form would be expensive if the whole of the operations were specially done for the purpose ; but where the trimming and so on have to be done in any case, the value of the ash would repay the cost of collecting the clippings.

AN OXIDISABLE VARIETY OF NITROGEN.—It has been found by Mr. T. M. Lowry (*Phil. Mag.*, 1914, XXVIII, 412) that air that has been subjected first to a silent and then to a sparking electric discharge shows the spectrum of nitrogen peroxide, apparently formed by the oxidation of a variety of nitrogen produced under the influence of the discharge. After a few seconds this oxidisable kind of nitrogen reverts to a form which can no longer be oxidised either by oxygen or by ozone, and it is suggested that this momentary production of modified nitrogen may play an important part in the technical processes of fixing atmospheric nitrogen. The chemically active form of nitrogen discovered by Mr. Strutt, and described at the time in "KNOWLEDGE," cannot be oxidised by ozone under the conditions described.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

CLASSIFICATION OF SEDIMENTS.—Although the chief characteristics of the various types of sediments are fairly well known, a paper by A. C. Trowbridge (*Jour. Geol.*, May–June, 1914), in which these characteristics are presented in a tabular form, should prove very useful in the examination of the various deposits now being laid down on the Earth's surface. Sediments are divided into aeolian, fluvial, pluvial, talus, glacial (including till and fluvio-glacial), lacustrine, and marine deposits (including shallow and deep water). Instead of a division into littoral and non-littoral, lacustrine deposits are divided into those of agitated waters, and those of quiet waters. Similarly, shallow-water marine deposits are classified into those of major agitation and those of minor agitation, the former resembling the near-shore lacustrine, and the latter the still-water lacustrine, save in the nature of the fossils. Emphasis is laid on the "lens and pocket structure" of fluvial deposits and on the intermediate nature of fluvio-glacial sediments, which are similar texturally to the fluvial, and lithologically to the glacial.

STREAM PIRACY.—Three interesting cases, showing different stages of development of the "intercision" type of river capture, are described in the Publications of the University of Virginia (No. 20, July, 1914). The first case occurs in a rejuvenated river system, where the main stream is entrenching itself, and at the same time approaching, by lateral cutting, a tributary, the junction with which is at present one and a quarter miles lower down. In the second case, both the main and tributary streams are

meandering, and two meanders are laterally cutting towards each other. Though they have not yet joined on the surface, the intervening rock, which is limestone, has been undercut to such an extent that a tunnel has been formed from the one stream to the other. In the third case, the junction of two streams has been moved one and three-quarter miles upstream by intercision, due to the cutting through of a ridge of chert which formerly separated two meanders.

SHAPE OF THE ANTARCTIC CONTINENT.—Probably the most discussed point in Antarctic physiography has been the question as to whether there is one continent or two; that is, whether there is a continuous range from Graham Land to South Victoria Land, or whether, as suggested by Mawson, Graham Land is united to King Edward VII Land, and separated by a faulted trough or rift valley from Victoria Land. The evidence has been discussed by Griffiths Taylor (*Geog. Journ.*, October, November, December, 1914), who reviews both the geological and physiographic data. The rocks of Prince Leopold Land are like those of South Victoria Land. Further, a comparison with the Australian coastal type points to the conclusion that the West Antarctic cordillera continues to King Edward VII Land, with an intermediate broad belt of lowland—the Ross Barrier—corresponding to the Tasman Sea between Australia and New Zealand. Another point in favour of this idea is that the Victoria Land mountains belong to the "Atlantic" or "subsidence" type, whereas Graham Land belongs to the "Pacific" type, which may be continued from the Andes by the South Georgian loop. The Royal Society Range is probably caused by a late Tertiary fault, while the foothills seem to be a typical "Senkungsfeld" area.

ANTARCTIC GLACIER TYPES.—In the same paper an elaborate account is given of the ice-fields of the Antarctic continent. Several types of glacier occur in close juxtaposition. Of those with large alimentation the great ice-cap, which is between two thousand and three thousand feet thick, has been shown to have but little movement. There are several piedmonts, the largest being the Wilson and Butter Point glaciers, which are probably residual from a former glaciation. There are also the large outlet glaciers and numerous small col and dendritic or tributary ones. All the forms of glacial action are well shown by one or other of these types. Thus, the action of the ice-cap and of the piedmont lobes is mainly protective. Glacial erosion, as commonly understood, is evidenced by the outlet glaciers, while "sapping" action, or cirque erosion, generally occurs on the steep slopes of the Royal Society range. An account is also given of the various stages of cirque formation and of glacial deposition. One interesting deduction is that the present conditions in South Antarctica are very unfavourable for glacier erosion, as well as for cirque erosion, which requires rapid alternations of freezing and thawing.

THE GULF STREAM.—In the same journal, Commander Hepworth discusses the origin and course of the Gulf Stream. Most ocean currents have a close connection with atmospheric currents, though the Earth's rotation is also a powerful factor. The north-east and south-east trade winds give rise to a drift current, which develops into the north and south equatorial currents. The Gulf Stream is primarily due to components of those which find their way into the Caribbean Sea; thence past Yucatan into the Gulf of Mexico, and finally through the Gulf of Florida. The other hypotheses as to its origin, based on temperature differences, on the silt brought by the Mississippi, and so on, are shown to be untenable. One interesting fact is the daily and monthly variation in the velocity, which has been correlated with the variation in the heights of the tides. While it has been maintained that the Gulf Stream disappears when it comes into contact with the Labrador current, it is more probable that it can be traced as far north-east as Spitzbergen and the Barents Sea. This is borne out by the evidence of the plankton and also by the occurrence, in these regions, of warm water of high salinity, such as is typically found in the Gulf Stream. The results of a series of investigations of the relations between sea temperature and air temperature, extending over the last ten years, indicate that no important temperature changes have occurred in the North Atlantic within historical times.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE ORIGIN OF THE BRIGHT AND DULL LAMINAE OF COAL.—In the December number of *The Journal of Geology* Mr. T. E. Savage discusses the origin of the bright and dull laminae which make up the mass of an ordinary coal, with especial reference to the coals of Illinois. Any theory of origin has to explain the extreme regularity and wide horizontal extent of these laminae (over several hundred square miles in Illinois); the alternation of the bright and dull layers; the predominance of mineral charcoal and of plant spores in the dull laminae; and the numerous pinnae and pinnules of ferns in the midst of mineral charcoal fragments. Mr. Savage's views on the accumulation of coal-beds may be summarised as follows: (1) The vegetable accumulation began in very shallow swamps. (2) That, as the swamps deepened gradually, the accumulation kept pace with the increasing depth. (3) In oft-recurring cycles of drought, successive levels of the vegetable mass were exposed to the air, and were so modified by partial atmospheric decay as to result in the formation of the dull laminae with their mineral charcoal. The bright laminae would thus be formed by decomposition out of contact with air. Quoting Mr. Savage in the above-mentioned paper: "The dull laminae and mineral charcoal partings of the coal-beds are the records of repeated interruptions of accumulation, during which the surface of the vegetable material in the swamp was above water and exposed to atmospheric decay, resulting in the destruction of the softer parts of the plant tissues, leaving them in an indurated and more or less skeletonised and fibrous condition. On resubmergence these residual portions of the vegetable materials were not so readily impregnated with the fundamental matter of the bog as were those parts of the mass that had not suffered partial atmospheric decay, and hence are of dull appearance. Such periods of arrested accumulation of the plant material, due to the exposure of the surface of the vegetable matter of the bog, would be favourable for the accumulation on such a surface of a relatively larger proportion of spores than would be mingled with the vegetable mass during periods of submergence and of normal vegetable growth in the bog, and the resistant nature of the spore cases would permit their better preservation than the ordinary plant tissues during such times of exposure. These conditions would explain the greater abundance of spores in the dull than in the bright laminae of the coal-beds. The variation in thickness of the dull laminae would be due to the unevenness of the surface of the exposed vegetable matter in the bog." These conditions also explain the alternation of the bright and dull layers, and their wide extent, since they were coterminous with the boundaries of the swamp itself.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

THE WEATHER OF APRIL.—Although April is the mid-spring month, when some warm and genial weather may reasonably be expected, yet there is perhaps no other month in which we are exposed to such great and sudden changes of temperature. The increasing power of the sun's rays and drying north-easterly winds cause excessive evaporation. Some days may be warm and genial, while,

on the other hand, days of wintry rigour are experienced, with heavy showers of hail or snow. Hence the old saying

"Changeable as an April day."

April was a very cold month in the years 1860, 1879, 1881, 1884, 1888, and 1908; and it was very mild in the years 1844, 1865, 1869, 1874, 1893, and 1894.

The average mean temperature at Greenwich for April is 47°·3; in 1865 it was as high as 52°·9; while in 1860 it was as low as 43°·3. The average maximum temperature is 57°·2; the highest mean was 66°·3, in 1865, and the lowest 51°·7, in 1908. The average minimum temperature is 39°·0; the highest mean was 42°·5, in 1850, and the lowest 34°·2, in 1852. The absolute highest temperature recorded was 81°·5, in 1865, on the 27th, and the absolute lowest 23°·0, in 1847, on the 17th. The average number of days on which the temperature falls to or below the freezing-point is three.

The average rainfall for the month of April is 1·61-in.; the greatest amount was 4·35-in., in 1829, and the least 0·06-in. in 1817. The heaviest fall in one day was 1·50-in., in 1910, on the 16th. The average number of "rain days" (*i.e.*, on which ·01-in. fell) is 12·0; the greatest number of days was twenty-one, in 1848, and the least two, in 1852.

The average amount of bright sunshine at the Kew Observatory, Richmond, is one hundred and fifty-two hours, or about five hours per day.

The average barometric pressure in London for April is 29·933-in.; the highest mean was 30·308-in., in 1817, and the lowest mean was 29·590-in., in 1829.

"April showers bring forth May flowers."

THE RAINFALL OF 1914.—Dr. H. R. Mill, the Director of the British Rainfall Organisation, in his account of the principal features in last year's rainfall, says that the noteworthy features of the monthly rainfall were the prevailing wetness of the four months February, March, November, and December. Of these February was wettest in Ireland, and December in Great Britain. The rainfall of December was exceptional in all parts of the Kingdom, but especially so in the South of England, where it was probably unprecedented in this respect. Of the remaining months, January was everywhere dry, and, following an unusually dry December, gave a character to the midwinter season of 1913–14 greatly in contrast with that exhibited in the same period of 1914–15. From April to October the rainfall was in general well below the average, though local thunderstorms in England brought the general fall of July slightly above the average, whilst that of August was above the average in Ireland for a similar reason. The persistent dryness of the seven months, and in particular the small rainfall of October, which was the driest month of the year, was probably as abnormal as was the great rainfall of December. Taking the British Isles as a whole, it appears that the rainfall for the year was six per cent. above the average, and so 1914 must be classed as a moderately wet year.

AUSTRALIAN WEATHER, 1911.—The following are the results of some of the observations for the year 1911 at several of the principal towns in Australia as given in *The Monthly Weather Report* recently issued by the Commonwealth Bureau of Meteorology:—

	Mean Temperature. °	Rainfall. in.	Evaporation. in.	Sunshine Hours.
Perth	63·2	23·38	66·34	2961
Alice Springs	70·0	7·09	97·10	—
Adelaide	62·9	15·99	48·14	2415
Brisbane	69·3	35·20	49·34	2510
Sydney	63·4	50·24	37·45	1996
Melbourne.....	58·6	36·61	38·87	1755
Hobart	54·6	26·78	31·98	1950

MICROSCOPY.

By J. E. Barnard, F.R.M.S.

LIGHT-FILTERS.—The wave-length of the light used for illuminating purposes has a very definite influence on the resulting microscopic image. A filter may be selected for one of three reasons: to improve the correction of the optical system—and this applies to both the substage condenser and the objective—to increase or decrease contrast in the image, or to increase resolving power. It is possible to combine, at least in part, all three qualities in one filter, although it is obvious that to obtain the best result each factor must be dealt with independently. In these days, objectives are so well corrected that the visual image is almost free from any very definite colour aberration but under certain exacting conditions it may become evident. A filter which will cut out the particular colours for which the objective is not corrected can easily be made. It may be assumed that objectives are corrected for that part of the spectrum which has the highest visual luminosity, the region of the green, yellow, and blue-green. It follows that if the colours at the extreme ends of the spectrum are eliminated—the red and violet, for instance—the resulting image will be free from any outstanding colour. There is no better filter for this purpose than that known as Gifford's F-line screen. It is made by dissolving malachite or methyl-green in hot glycerine, the strength of solution depending on the thickness of screen used. In addition, a thin piece of signal-green glass must be immersed in the cell, to cut out the outstanding red which otherwise passes. Alternatively, the cell may be made up with one of its sides of signal-green glass, that is, if the cell is of the type which can be taken apart for cleaning purposes. The only objections to the Gifford screen are that the dyes mentioned are not very stable in solution, and that the luminosity of the screen is not high, as its maximum transmission is in the blue-green. A screen that is quite permanent, and that has higher luminosity, is Zetnow's filter. This is perhaps the most useful of any, either for visual or photomicrographic purposes. It allows light of wave-lengths between five hundred and seventy and five hundred and fifty micro-millimetres to pass. It is made by dissolving ten grammes of pure dry cupric nitrate and one gramme of chromic acid in fifty cubic centimetres of distilled water. The thickness of liquid should be one centimetre. If it is not convenient to have so thick a cell, the solutions may, of course, be more concentrated, the relative quantities of each substance being maintained. Another method is to keep ready saturated solutions of copper sulphate and bichromate of potash, and to mix them as required. A precipitate is thrown down, which dissolves in glacial acetic acid. The screen may thus be varied from yellow-green to blue-green to suit the objects under examination. The influence of a suitable screen on resolution is well known, although it is perhaps not so thoroughly realised in practice as it might be. Resolution is dependent on the wave-length of the light used in the medium between the object and the front lens of the objective, and on numerical aperture. The latter factor is a constant, that is, assuming that the full aperture of the objective is utilised. The former is a variable, and, in the case of white light, is the mean wave-length of the light emitted by the radiant. Reduction of the mean wave-length therefore, by cutting out the red, for instance, increases possible resolution. By using a screen which effectively cuts out the red and yellow, improvement may be effected. The method is fairly obvious, but further reference to the matter will be made in this column in succeeding numbers.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundred and fifth ordinary, which was also the forty-ninth annual, meeting of the Quekett Microscopical Club was held on Tuesday, February 23rd, at 20, Hanover Square, W., the President, Professor Arthur Dendy, D.Sc., F.R.S.,

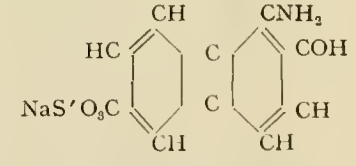
invited Professor Minchin to occupy the chair, and gave his annual address. The title was "The Biological Conception of Individuality." Professor Dendy observed that probably most of us think that we can recognise and define an individual, but that, though this is true of an individual man or dog, or an individual oak tree or cabbage, if we carry our investigations below the surface, we find many cases that are not a little puzzling, and the purpose of the address was to enquire whether it is really possible to frame a definition of individuality, from a biological point of view, that will be of general applicability throughout the animal and vegetable kingdoms. There appeared to be two main paths by which the problem could be approached: the morphological and the physiological. On the one hand, it was possible to enquire what consitutes a perfect individual from the point of view of structure; and, on the other, as to what constitutes an individual as regards function. In the case of the higher animals the question might also be approached in a third way, namely, from the psychological standpoint. The structure of various unicellular and colonial organisms, and of many of a higher development, was discussed, and difficulties which arise in deciding their claim to individuality commented upon. Two examples from the higher class may be given. Taking a colonial organism—say an obelia or sertularia—the fertilised egg develops into a single individual, but that individual does not stop developing when it has attained its full growth: it branches out and produces other individuals by a process of budding, and in the colony thus formed it is impossible to say where one individual ends and another begins, though it may be quite possible to say how many individuals there are altogether by simply counting heads. Perhaps the most interesting case was one which well sums up difficulties occurring, especially from the physiological point of view. It may be given in Professor Dendy's own words: "Many of the higher animals, though they do not form colonies in the morphological sense, have the habit of living together in social communities, which we may regard as colonies of completely separated individuals. The Honey Bee is a familiar example. In a hive of Bees we find individuals of three kinds, easily distinguished from one another both by habits and by structural peculiarities. The Queen is a perfect female, and is alone capable of laying eggs. The ordinary workers are imperfect females, which have sacrificed the power of reproduction, and concentrated their energies upon the collection of food and other important services necessary for the welfare of the community as a whole. The Drones are males: they do no ordinary work; their sole function is to fertilise the Queen. None of these different kinds of individuals could live a really independent life: they are all mutually dependent upon one another. The morphologist, however, could not refuse to regard them as separate individuals, and probably the physiologist would agree with him. But, if we are to be strictly logical, from the physiological point of view the complete individual can be nothing less than the entire community." . . . "It appears, then, to be hopeless to seek for any biological definition of individuality that can be applied to more than a very limited number of cases: we have constantly to modify our ideas on the subject as we pass from one group of organisms to another, and everything depends upon the point of view." . . . "Individuality, though a very real, is a very elusive, phenomenon, and one which perhaps lies outside the legitimate domain of the biologist. We can do little more than collect the remarkable facts that confront us so frequently in the course of our investigations, and hand them over to the philosophers to deal with as best they can."

PHOTOGRAPHY.

By Edgar Senior.

PAPIER MINÉRAL.—One of the most useful of photographic materials is a form of tissue paper, known as "papier minéral," readily obtainable at most photographic dealers. A sheet attached to the glass side of a negative affords great facilities for alterations and improvements in negatives generally, as it may be worked upon in various ways to modify the effect produced in printing. In landscape work, the appearance of distance may be made more real by its means; and it is also one of the greatest aids to successful vignetting. The opening in the vignetting mask, if covered with a piece of "papier minéral," will enable a much softer and a more easily controlled vignette to be obtained, and at the same time allow also advantage to be taken of direct sunlight in printing, should it be necessary; and in a variety of ways it will assist the photographer to improve his work. In almost all cases where ground glass is useful this semi-transparent paper can be made to take its place; thus a piece stretched over plain glass can be used as a focusing screen, should the latter get broken when travelling. Then, again, in portraiture "papier minéral" is useful for covering light movable screens or pasting direct on to a skylight, and sunlight may be filtered through it, and effects produced, which are in every way satisfactory; and on dull days it does not obstruct the light sufficiently to appreciably lengthen the time of exposure. When using "papier minéral" as a means of obtaining the effect of atmosphere in the print from a landscape negative by causing the more distant objects to appear more or less grey—"the greater the distance the greyer the objects should appear"—it must not be forgotten that the lights of distant objects are grey compared with those in the foreground, and care must be taken that these distant lights do not appear too strong in the print. To obviate this, resort is sometimes made to strengthening those in the foreground and middle distance, but this requires to be done very carefully. Thus, by means of tissue paper, it is possible to produce in the photographic print an effect more nearly in accord with nature than the negative alone would be able to render, owing to its imperfect gradations. If the photographic process gave a true rendering of all objects depicted, then resort to any such means would not be necessary; but as it usually falls short of doing so, any means may be considered legitimate that will enable the desired end to be obtained, and produce the effect that a perfect process would do. In all cases, however, care must be taken not to overdo it.

DEVELOPMENT WITH EIKONOGEN.—The developing properties of this substance were first pointed out in 1881 by Professor R. Meldola, who prepared the acid from which the sodium salt was afterwards obtained, and introduced under the name of "eikonogen," a name derived from the Greek, and signifying "image-producer." In its pure state eikonogen is a white substance. It is the sodium salt of amido-β-naphtholsulphonic acid, its constitution being expressed graphically as follows:—



or $C_{10}H_5OHNH_2SO_3Na.2H_2O$

The substance is somewhat sparingly soluble in water, but dissolves more readily in the presence of alkalies Sodium sulphite is the best preservative, and acids added to the solution cause the free acid to be precipitated in the form of white needles. It can be recrystallised from solution in sodium sulphite. Eikonogen as a developer was patented in 1889 by Dr. Andresen, of Berlin. It is very quick in its action, and produces soft negatives of a very fine colour, and on this account it is invaluable in portraiture. It is also specially suited for instantaneous work, and it has been claimed that it will give more detail

with a short exposure than many of the alkaline developers. This, however, appears doubtful, as it is believed that the detail brought out is similar, whatever be the developer employed. The advantage of eikonogen is that it prevents that excessive contrast that is likely to be obtained at times with "pyro" and still further with hydroquinone; and the great difficulty often experienced by those who have been used to either pyro- or hydroquinone as a developer has been that of not getting sufficient density in the image with eikonogen. But the entire absence of fog allows of the image being afterwards intensified to the required extent without difficulty. Then eikonogen may be mixed with either "pyro" or hydroquinone, or may be used after these at any stage of development, so long as the alkali employed as the accelerator is a carbonate. Thus, suppose that, with pyro as the developer, there is the appearance that the high lights are becoming too dense before the details in the less illuminated portions of the subject are well out; then these may be developed without any further perceptible increase of density by washing off the "pyro" solution, and applying one of eikonogen and carbonate of soda, the quantities being regulated according to the stage that the negative has reached. It should also be mentioned that the solution of eikonogen should be kept as near as possible at a temperature of 65° F., as it is very insoluble in cold water, and will crystallise out, and therefore lose nearly all its developing power. With this developer the quantity of sulphite required appears to vary with the nature of the subject and the plate used; it must, however, be at least equal to that of the eikonogen, and may often with advantage be increased to twice, or even three times, that. Except for very quick exposures, a small quantity of bromide should be used in the developer, as it appears to have the effect of producing greater density in the negative. As, however, restrainers act much more powerfully than with pyro, only three or four drops of a ten-per-cent solution should be added to each ounce of developer; and the bromide must be potassium, and not ammonium. Development with eikonogen may also be conducted tentatively by adding the alkali in small quantities at a time. A saturated solution of potassium carbonate should be made, which may be added in drops as development proceeds. The developer may also be allowed to remain stationary upon the plate without markings of any kind appearing, provided that the solution is quite free from any deposit; and, if required, further development can be instantly checked by immersion of the plate in a one-per-cent. solution of either acetic or citric acid. Over-exposure can, to an extent, be corrected by increasing the quantity of sulphite in the developer, although eikonogen cannot be said to allow of much latitude in this direction. Of the many formulae that have been given from time to time the following will be found useful for portrait or landscape work generally:—

Portraits and Landscapes.

Eikonogen...	5 grains
Soda sulphite	22 ,,
Soda carbonate	16·5 ,,
Water (distilled)	1 ounce

For very quick exposures the following formula is to be recommended:—

For Very Short Exposures.

Eikonogen...	14 grains
Soda sulphite	75 ,,
Potassium carbonate	30 ,,
Water (distilled)	1 ounce

Then, again, eikonogen is especially suitable for use with isochromatic plates, and, when mixed with hydroquinone, yields results on these plates that are excellent in every way. The following formulae, which were originally published by Carbutt, are for a developer of this nature which the writer has used repeatedly with great success:—

Carbutt's Formula.

For Snapshots on Isochromatic Plates.

Eikonogen...	2 grains
Hydroquinone	1 grain
Soda sulphite	12 grains
Potassium carbonate	6 ,,
Water (distilled)	1 ounce

For Portraits on Isochromatic Plates.

Eikonogen...	1·6 grains
Hydroquinone	0·8 grain
Soda sulphite	10 grains
Potassium carbonate	5 ,,
Water (distilled)	1 ounce

For Landscapes on Isochromatic Plates.

Eikonogen...	1·9 grains
Hydroquinone	0·95 grain
Soda sulphite	11 grains
Potassium carbonate	3·6 ,,
Water (distilled)	1 ounce

Care should be taken not to over-expose the plates, when these mixed developers will be found to do everything required, if the development is carried far enough. Sufficient has now been said as to the value of eikonogen alone, as well as when mixed with hydroquinone; and, as the substance can be obtained at a cost less than that of pyro at the present time in many cases, it is worth while giving it a trial.

PHYSICS.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.

THE COOLIDGE *X*-RAY TUBE.—This tube differs very much from the usual form of *x*-ray bulb, both in construction and in the principles underlying its operation. It is manufactured by the British Thomson-Houston Company, which has communicated a detailed account of Dr. Coolidge's invention to *The Electrician* (January 15th, 1915). The usual concave cathode is replaced in the new tube by a spiral of thin tungsten wire, which is heated to incandescence by a small battery. This wire gives out the necessary stream of corpuscles, which, when they strike the anti-cathode, give rise to the *x*-rays. The anti-cathode also serves as the anode, and is made of wrought tungsten. When the tungsten wire is cold the tube is capable of withstanding an electrical pressure of one hundred thousand volts without the insulation of the vacuum breaking down, so perfect is the exhaustion. When, however, the wire is hot, the tube becomes conducting in one direction, namely, through the space from the tungsten plate to the spiral, the current being carried entirely by the stream of corpuscles issuing from the hot wire. It is claimed for the new tube that its action is more easily controlled than that of the old tube, and in particular that the conditions of working are more readily reproduced.

VERY SHORT-WAVED ULTRA-VIOLET LIGHT.—The wave-length of the light in the middle of the visible spectrum is about six thousand tenth metres, a tenth metre being 10^{-10} metres. Stokes first studied the ultra-violet region of the spectrum, and carried his work as far as wave-length 1800 or so. The region lying between 4000 and 2000 may be called the ordinary ultra-violet region. This radiation is remarkable for its photographic and fluorescent effects. Schumann many years ago carried the knowledge of the ultra-violet up to the estimated wave-length 1000. The whole work had to be executed in a spectroscope which could be evacuated, as air is opaque to these short waves. Special photographic plates had to be used, and the prisms and lenses constructed of fluorite. By the use of a concave grating in a vacuum, Lyman has recently pushed the limit of the spectrum up to nine hundred tenth metres, and has hopes of still further invading the unexplored region lying between the shortest known ultra-violet waves and the longest waves of the *x*-rays. These have a wave-length of the order of one tenth metre, while shorter still are the γ-waves given out by radio-active bodies.

A NEW METHOD OF COUNTING THE MOLECULES OF A GAS.—In *The Astrophysical Journal* for December, 1914, Fowle describes a new method for determining the number of molecules n_0 in a cubic centimetre of a gas at normal temperature and pressure. The method consists in determining the transmissibility of light of various wave-lengths through the dry air vertically above Mount Wilson, and computing the results by a formula due to Rayleigh. This formula gives the coëfficient of transmission in terms of the refraction and of the number of the particles in unit volume. Rayleigh was the first to regard the molecules of air as capable of acting as scattering particles, and considers that, while as seen from the Earth's surface, much of the light from the sky is due to comparatively gross suspended matter, yet an appreciable proportion is attributable to the molecules of the air themselves, and that at high elevations where the blue is purer the latter part may become predominant. Fowle's result is $n_0 = (2{\cdot}70 \pm {\cdot}02) \times 10^{19}$, which is in close accord with the best determinations of this constant by other methods.

FRICTIONAL ELECTRICITY.—Very little is known about electrification by friction, so that a paper on this subject by Morris Jones is very welcome (*Phil. Mag.*, February, 1915). Measurements were made of the charge produced on a surface by friction and of the frictional work spent in generating it. The specimens were insulated, and pressed against a rotating wheel covered with various materials. The charge generated was measured by a quadrant electrometer, and the work done could also be determined. It was found necessary to give the insulators a rest after each rub, for, if an insulator was rubbed a number of times in succession, the deflexions rose to the maximum, though the work done was the same for each rub, and less than that required to give the maximum for a first rub. When the normal pressure between the specimen and the rubber was maintained constant, it was found that for each pair of materials the charge reached a maximum as the quantity of work was increased. The sign of the charge was plus on quartz, glass, fluor-spar, Iceland spar, and heavy spar when rubbed on flannel, silk, and chamois leather, but negative on ebonite, amber, and sealing-wax when rubbed on the same materials. When specimens of various metals were rubbed against silk, the results were more complicated, the charge varying both in magnitude and sign with the state of the surface; the maximum charge proved to be independent of the pressure and velocity. A tentative mathematical theory of the effects is given based on the assumption that the friction removes electrons from either the rubber or the specimen at a speed proportional to the rate of working.

QUARTZ GLASS.—This material is surpassed only by invar in respect to its invariability of size with temperature. It was discovered by Professor C. V. Boys, who used threads of this material to support the deflected masses in his classical research on the Newtonian constant of gravitation. Boys showed how to prepare these threads by the bow and arrow and other methods, and also prepared small pieces of rods and tubes before the oxy-hydrogen blowpipe. When once quartz has been fused it is very easy to work, as it does not crack with sudden change of temperature. This is partly owing to its low coëfficient of expansion, but also probably to its great mechanical strength. Shenstone still further improved the methods of making fused silica, and the material is now a commercial article, being obtainable in two grades: one perfectly clear and colourless, the other being silky and translucent in appearance. The methods of manufacture have been so far perfected that complicated apparatus of quartz glass can now be easily made, and a preliminary difficulty as regards sealing the leading in wires for electrical purposes has been overcome completely. This wonderful and beautiful product has already been applied to some commercial purposes, such as for making electric lamps, and the extension of its uses to various other fields is certain.

RADIO-ACTIVITY.

By Alexander Fleck, B.Sc.

ANNUAL REPORT.—The report issued annually by the Chemical Society always devotes a section to the progress made in radio-activity during the past year. Most of the questions raised in the section of the report which has just been issued have been mentioned from time to time in these columns. The three following subjects, dealt with more fully in the report are, however, of some importance, and may briefly be referred to now.

NEW WORK ON THE DISINTEGRATION SERIES.—Fajans and Towara have announced, in the *Naturwissenschaften* (1914, page 685), that they have discovered a radio-active substance which they have not been able to separate from bismuth, and which gives α-rays. The activity of the bismuth which has thus been obtained is five times as active as an equal quantity of uranium; and, deducing its period from the range of its α-rays, the period of average life of this "radium-H" is between one hundred thousand and one million years.

THORIUM ACTIVE DEPOSIT.—It has been generally accepted that when a radio-active element underwent dual disintegration we had a homogeneous collection of atoms which had the faculty of choosing in which of two ways they could disintegrate. If the experiments of Wood (*Proceedings Physical Society*, Volume XXVI, page 248) are confirmed, a large modification either of our views on dual disintegration or on the evolution of the radio-elements through the Periodic Table will be required. The experiments in question dealt with the volatilisation of thorium active deposit, and seemed to show that the substance hitherto referred to as thorium-C is composed of two elements, one of which commences to volatilise about 200° C. below the other.

ATOMIC-WEIGHT DETERMINATIONS OF RADIUM AND URANIUM.—Despite the most careful atomic-weight determinations, there is still a greater discrepancy between the values obtained for these elements than there should be if the three α-particles emitted between uranium-I and radium had the same atomic weight as helium derived from the atmosphere, namely, 3·99. The writer of the report—Professor Soddy—therefore suggests that it is an open question whether the law of the conservation of mass accurately holds in radio-active change. To the present writer it seems that a more probable explanation would be that radio-active helium is an "isotope" of atmospheric helium, but of a slightly higher atomic weight, just in the same way as Ashton's meta-neon had an atomic weight of 22 compared to that of 20 for atmospheric neon.

ACQUIRED RADIO-ACTIVITY.—Sir W. Crookes has recently published a paper (*Philosophical Transactions of the Royal Society*, Volume CCXIV, page 433) describing the behaviour of diamonds when buried in a radiferous salt or exposed to radium emanation. As is to be expected, the gems, just like any other material similarly placed, are coated with the active deposit, and so possess the "acquired activity." The author, however, finds this difference, that the material producing the activity so obtained can easily be dissolved from glass; while, when it is obtained on diamond, it can withstand the most vigorous chemical agents. The activity is, so far as can be ascertained, constant over a period of years.

In the paper referred to Sir W. Crookes does not attempt to explain the phenomena observed, although it would be easy to suggest a number of explanations capable of experimental verification.

CONDENSATION OF THORIUM AND RADIUM EMANATIONS.—In *The Philosophical Magazine* for March the present writer also contributes a paper on the condensation of these two emanations. The object of the research was to find out whether isotopes had or had not the same temperature of condensation. It was found that in a mixture of the two emanations at atmospheric pressure, thorium emanation appeared to be condensed before radium emanation; while, if the experiment was made in a vacuum, the reverse was the case. From theoretical considerations it was shown that results of this nature are to be expected, even if individual atoms of each emanation had identical condensation points. The difference in behaviour is in all probability due to the different periods of average life. Indirect evidence was obtained in one experiment that the two emanations behaved identically in respect to their condensation and volatilisation.

By altering the external conditions the condensation point of either emanation can be varied between $-150°$ C. and $-185°$ C.

RELATION BETWEEN *X*-RAY WAVE-LENGTHS AND ABSORPTION.—A paper on this subject, by Professor W. H. Bragg, appears in *The Philosophical Magazine* for March. It deals with the absorption of rays emitted by substances when these are bombarded with cathode or *x*-rays. It is well known that secondary rays are of two types, and are characteristic of individual elements. The main conclusion reached is that it is probable that "the characteristic rays of a substance form a system which can only be excited as a whole." In the meantime this result has been proved to be correct for some six or so elements; if, however, further work enables it to be stated in a generalised form applicable to all the elements, an important step will have been made in our knowledge, not only of the material, using the word in its widest sense, inside an atom, but also of how that material is held together.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

RELATIVE LENGTHS OF OUR TOES.—Onera A. Merritt Hawkes finds that there are three types of feet, of which two are common. The first or great toe may project beyond all the others (L type). The second toe may protrude, not only beyond the third, fourth, and fifth, but also beyond the first (S type). This is much less common than L. The first and second toes are of the same length, and longer than the others (E type). This is very unusual. There is some limitation in regard to sex, the S type occurring more commonly in females than in males. As the S type is commonest in the foetus, it may be said that in this, as in some other features, woman is a more youthful type than man. In inheritance the L type is irregularly dominant over the S type of foot.

PHEASANTS AND MUTATION.—Mr. C. William Beebe, the Curator of Birds to the New York Zoölogical Society, has been studying pheasants for some years, and his opinion on the factors of evolution is well worth having. He says that he began with some prejudice against the "mutation theory" (of brusque, discontinuous, or saltatory variations), but that the more he observed such species as the golden and Amherst pheasants (*Chrysolophus pictus* and *amherstiae*), the colour relations in both sexes, and the results of hybridism, the more necessary some such phenomena as saltations appeared to be in these particular instances. The genus *Phasianus* seems to afford good illustrations of continuous variation, and the genus *Euplocomus* of saltatory variations. Both forms have been operative in nature.

CROCODILE'S NEST.—Mr. W. Schultze, of the Biological Laboratory at Manila, describes the nest of a crocodile (*Crocodilus palustris*) near Taytay, Palawan. A peculiar mound of grass on the shore of a lake attracted attention, and it was found to be a crocodile's nest. A space about eight metres long and five metres wide had been cleared of the coarse, wiry grass (*Ischaemum*) which grew there, and a mound had been made 2·5 metres in diameter at the base and 1·5 metres in height. The grass was mixed with sand, and was moist. About the centre of the mound there were thirty eggs in several layers. The egg is oblong ellipsoidal, with a very hard porous shell, a high porcelain lustre, and a strongly marked opaque white band around the middle (girth). It was found that the time of incubation in the Philippines is between seventeen and eighteen weeks.

HOW A STING-RAY PROTECTS ITS EYE.—It is well known that the eyes of fishes are lidless, and cannot be closed like those of most higher vertebrates. Sometimes, however, they are well protected from injury, and B. Sundara Raj gives a good example in *Trygon kuhlii*, one of the sting-rays. It lies buried in the sand with the eyes, the spiracles, and a portion of the formidable spined tail projecting. If sand or other particles be dropped down, the upper margin of the spiracle nearest the eye forms a projecting fold which serves both to protect the eye and to exclude foreign objects from the spiracle.

SIZES OF RED BLOOD CORPUSCLES.—An interesting suggestion has been made by Dr. J. Burton Cleland that specialisation is attended with a reduction of the size of the red blood cells. Thus, among fishes, those of Ceratodus are 39×23 to 25μ, which is "cumbersome"; those of Elasmobranchs vary from $18 \times 12{\cdot}5$ to $23 \times 13{\cdot}5\mu$; those of Teleosteans range from 9×7 to $13{\cdot}5 \times 10{\cdot}3\mu$. In *Therapion unicolor* they are almost spherical, 6 to 8μ. Similarly in birds the Emu has $15{\cdot}5$ to $16{\cdot}5 \times 8{\cdot}5$ to $9{\cdot}5\mu$; the Grebes, Penguins, Herons, Pelicans, and the like have approximately $14 \times 8\mu$; in Passerine birds (except Corvidae) there is a definite tendency to smaller cells, 10 to 12×5 to 7μ.

STINGS OF JELLYFISHES.—The stinging threads of the common jellyfish (*Aurelia aurita*) are not strong enough to pierce the ordinary human skin, but bathers on British coasts have sometimes painful experience of the virulence of the orange or the blue species of *Cyanea*. In other waters there are much more formidable jellyfishes. Thus Mr. S. F. Light, in describing Philippine medusae, notes of *Chiropsalmus quadrigatus* that the sting of the tentacles is very dangerous. Swelling and inflammation begin almost immediately, blisters form, the heart action is impaired, respiratory spasms and nervous twitchings of the muscles ensue, and there is intense general pain. The natives of Palawan reported that the sting may be fatal. Another dangerous form is *Dactylometra quinquecirrha*, which causes severe poisoning. The native remedy is sugar solution taken internally and applications of vinegar externally.

NESTS OF FALSE SCORPIONS.—A very fine piece of observational work has been done by Mr. H. Wallis Kew, who has for the first time described the whole process of nest-making in the little creatures known as false scorpions, or pseudoscorpions, which are moderately well represented in Britain. Nests are made by all individuals of both sexes for moulting, for brood purposes, and sometimes for hibernation. The interior is lined with dense spun tissue, almost like silk paper, which takes days or even weeks to make. There may be an external covering of earthy or vegetable materials attached by silk. The silk is formed by glands in the cephalothorax, and is conveyed by ducts to the tips of the chelicerae, or first pair of appendages. The silk is drawn out in separate viscid threads, which may coalesce or remain separate. There are five or six from each chelicera, but these may form one. The spinning is associated with continuous forward and backward movements of the body, and with lateral movements of the chelicerae.

HYBRID COCKATOOS.—Dr. Ernest Warren, of the Natal Museum, describes a very interesting case of hybridism. The male bird was the common Sulphur-crested Cockatoo (*Cacatua galerita*), the female the so-called Slender-billed Cockatoo (*Licmetis nasica*). The hybrid seemed to be a thorough blend. Out of ten characters it was nearer *Cacatua* in five, nearer *Licmetis* in one, and almost exactly intermediate in four. In every character examined, with the possible exception of the coloured and non-coloured lores, there is very obvious blending of the male and female characteristics. There was no evidence of Mendelian inheritance.

HABITS OF TESTACELLA.—The Testacellid Slugs differ widely from the other British Slugs: Limacidae and Arionidae. They retain a small external shell, visible on the surface, near the posterior end, whereas in the others the shell is either a hidden vestige or quite absent. Again, while most British Slugs are omnivorous, the Testacellids are essentially carnivorous, and feed largely on Earthworms caught by night. Mr. Charles Oldham writes: "The Earthworm is seized by a sudden, rapid extrusion of the Slug's odontophore or lingual ribbon, a structure provided with close-set rows of long, slender, barbed teeth, which afford an excellent hold on the Worm's soft body, and the whole of this stupendous meal, in bulk perhaps three times that of the Slug, is gradually ingested." In its early struggles the Earthworm often dashes the Slug about, but the bull-dog grip is not relaxed. In hot, dry weather and in the cold of winter Testacella lies inactive in a cocoon-like cell made of earth and mucus. The elliptical eggs, about five millimetres in longer axis, are deposited underground. There are three British species.

STRENGTH OF SPONGE-CURRENTS.—Ever since Robert Grant discovered the currents produced in water by living sponges the hidden activity of these often very vegetable-like animals has excited interest. The last contribution to the subject is Professor G. H. Parker's estimate of the strength and volume of the currents. In *Stylotella* the pressure is equal to a column of water 3·5–4 millimetres in height. In seven others it was less, usually a little over two millimetres. In *Spinosella sororia*, the common Bermuda finger-sponge, a tube put into an exhalent aperture, or osculum, showed that the rate of flow is about four millimetres per second, and the rate of discharge about seventy-eight litres per day from each osculum—over four hundred and fifteen gallons for the whole sponge. As the experiments were made in the laboratory, the estimate is probably under the mark. An undisturbed specimen of *Spirastrella* at low water was found capable of overcoming a pressure of four millimetres of sea water. Big sponges often produce deformations of the surface of the sea above them, as a vigorous spring does; but Professor Parker's interesting investigations indicate that the currents flow at low pressure.

COMPANIONS OF JELLYFISHES.—It is well known that some medusae swim about with horse-mackerels (Carangidae) in the shelter of their flowing lips. Mr. S. F. Light describes this in a Philippine jellyfish, *Rhopilema visayana*, with which a species of *Caranx* has established a companionship. "The fish would be seen playing about among the mouth, arms, and appendages, and on being alarmed would disappear under the edge of the bell, between the arms or in the subgenital porticus." A similar condition was found in the case of *Lobonema mayeri*. Inside the *Rhopilema* there was usually a crab (*Charibdis crucifera*), considerably paler than is typical for the species, which suggests a prolonged residence within the medusa. It is interesting to notice Light's observation that the companion fishes were seen eating *dead* specimens of *Rhopilema visayana*, though their relation with the living forms seemed to be quite friendly. "I am told," Mr. Light adds, "that *R. visayana*, which is closely related to the common edible medusa of Japan (*R. esculenta*), is used for food by the inhabitants of the east coast of Leyte, where it is preserved in vinegar."

COLOUR CHANGE OF NEWTS.—The colour changes of the Palmated Newt (*Molge palmata*) are well described by Mr. Charles Oldham. "Individuals living in a pond with a dark, muddy bottom are dark green in colour, and in consequence when at rest are almost invisible from above; similarly those in a pond with a bottom of yellow clay are yellowish in colour and alike inconspicuous. If, however, one of the dark green Newts be placed in a glass vessel upon a white surface, it will, in the course of a few hours, become yellowish-drab in colour, but often paler in tint than the Newts which rested on the yellow clay; whilst, if one of the yellow-skinned Newts be taken from the pond with the bottom of yellow clay and placed into a glass vessel, it will be seen presently to exhibit greenish spots and marblings over the whole of the upper surface, and ultimately, by the expansion of these green areas, to acquire an almost uniform dark-green tint over the whole of the surface exposed to view from above. The green will, indeed, be darker in tint, provided the glass vessel stands upon some dead-black surface, than in the Newt which was taken from the pond with the bed of dark mud." (*Trans. Hertfordshire Nat. Hist. Soc.*, Volume XV, 1915, page 207.) The colour-change depends on the contraction and expansion of the living matter of the pigment cells, which are under the control of peripheral nerves. The stimulus from the coloured environment first affects the eye, for blind animals do not change.

NUMBER OF SPORES IN A MYXOMYCETE.

By W. B. GROVE, M.A.

In November, following the directions of Mr. S. P. Bolton, I found on a tree-stump a huge mass of aethalia of the Myxomycete (*Brefeldia maxima*). The crowded aethalia covered a space of about six square feet, and were just ripening their spores. As the number of spores was evidently enormous, it was thought it would be interesting to make an estimate. For this purpose a gramme of spores and capillitium was taken and shaken up in two hundred cubic centimetres of water, with a little ether to loosen the spores from one another. After thorough shaking, the number of spores was counted, in the ordinary way, by a blood-corpuscle-counting apparatus of Zeiss. Allowing about six per cent. for capillitium, the number worked out at 10^9 in a cubic centimetre. Thus, in the whole mass covering the stump, roughly estimated at about five hundred cubic centimetres, there were half a million million spores.

This result can be checked by geometrical considerations. The aethalium contains nothing but spores and capillitium; the size of the spores varies from 9 to 12μ. Taking 10μ as an average, the volume of a spherical spore is approximately $\frac{1}{2} \cdot (\frac{1}{10})^6$ cubic millimetres.

If equal spheres are packed as tightly as possible in a given space, geometry teaches us that about twenty-six per cent. must be allowed for the spaces between the spheres; if, then, we allow six per cent., as before, for capillitium, and a further eighteen per cent. for the obvious loose packing and occasional larger spores (this last amount is, of course, a mere guess), we get a total allowance of fifty per cent.

Therefore the number of spores in one cubic centimetre

$$= 50\% \text{ of } 2 \times 10^6 \times 10^3 = 10^9.$$

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 21.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
May 1	2 30·5	N.14·8	16 18·0	S. 26·3	2 29·6	N.14·5	0 22·1	N. 0·6	23 24·2	S. 5·0	5 55·3	N.22·7	21 12·7	S.16·8	7 59·2	N.20·3
,, 6	2 49·6	16·3	21 23·3	S. 15·7	3 11·6	18·5	0 44·2	2·9	23 27·7	4·6	5 57·5	22·7	21 13·0	16·8	7 59·5	20·3
,, 11	3 9·0	17·7	1 9·8	N.12·0	3 54·4	21·8	1 6·4	5·1	23 31·1	4·3	5 59·8	22·7	21 13·2	16·8	7 59·8	20·3
,, 16	3 28·7	18·9	5 15·8	N.27·5	4 35·4	24·1	1 28·7	7·4	23 34·4	3·9	6 2·2	22·7	21 13·3	16·8	8 0·2	20·2
,, 21	3 48·6	20·0	9 33·6	N.14·5	5 12·5	25·3	1 51·3	9·6	23 37·4	3·6	6 4·8	22·7	21 13·4	16·8	8 0·7	20·2
,, 26	4 8·7	21·0	13 44·7	S. 15·9	5 44·3	25·6	2 14·2	11·7	23 40·3	3·3	6 7·3	22·7	21 13·3	16·8	8 1·1	20·2
,, 31	4 29·0	N.21·8	19 9·6	S. 25·4	6 9·6	N.25·2	2 37·5	N.13·7	23 43·0	S. 3·1	6 10·0	N.22·7	21 13·2	S.16·8	8 1·7	N.20·2

TABLE 22.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Moon. P	Greenwich Midnight.	P	B	Jupiter. L_1	Jupiter. L_2	T_1	T_2
	°	°	°	°		°	°	°	°	h. m.	h. m.
May 1	− 24·4	−4·1	309·3	+ 7·3	May 1	−25·3	+1·5	129·6	267·7	8 27 *e*	4 36 *e*
,, 6	23·4	3·6	243·3	−18·0	,, 8	25·3	1·6	154·0	238·7	7 47 *e*	5 24 *e*
,, 11	22·3	3·0	177·1	−20·9	,, 15	25·4	1·7	178·6	209·8	7 6 *e*	6 12 *e*
,, 16	20·9	2·5	111·0	− 2·6	,, 22	25·4	1·7	203·2	181·0	6 26 *e*	7 0 *e*
,, 21	19·5	1·9	44·9	+18·5	,, 29	25·4	1·8	228·0	152·4	5 45 *e*	7 47 *e*
,, 26	17·8	1·3	338·7	+19·1							
,, 31	− 16·1	−0·7	272·6	− 8·4							

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}7$ respectively.

The data for the Moon and Planets in the Second Table are now given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northwards at a slackening pace. Its semi-diameter diminishes from 15′ 54″ to 15′ 48″. Sunrise changes from $4^h\ 36^m$ to $3^h\ 52^m$; sunset from $7^h\ 19^m$ to $8^h\ 4^m$. The Sun's surface is likely to repay careful scrutiny, owing to the recrudescence of activity.

MERCURY is in superior conjunction with the Sun on 1st; then it is an evening star, well placed for observation. East Elongation, 23° from Sun on 31st. Semi-diameter increases from 2½″ to 4″. Illumination diminishes from Full to ⅞.

VENUS is a morning star. Illumination increases from ⅘ to ⅚. Semi-diameter diminishes from 6½″ to 6″.

THE MOON.—Last quarter $6^d\ 5^h\ 23^m{\cdot}m$. New $14^d\ 3^h\ 31^m\ m$. First quarter $22^d\ 4^h\ 50^m\ m$. Full $28^d\ 9^h\ 33^m\ e$. Apogee $14^d\ 9^h\ e$. Perigee $28^d\ 6^h\ e$, semi-diameter 14′ 43″, 16′ 46″ respectively. Maximum librations 6^d 7° W., 14^d 7° S., 22^d 8° E., 27^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 24).

MARS is still badly placed, near Venus on 14th.

JUPITER was in conjunction with the Sun on Feb. 24th, and is still difficult to observe. Equatorial diameter 36″, Polar 34″.

Configurations of satellites at $3^h\ 30^m$ a.m.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
May 1	2	○	134		May 17		○	1243	
,, 2	1	○	234		,, 18	21	○	34	
,, 3		○	1234		,, 19	23	○	14	
,, 4	21	○	34		,, 20	31	○	24	
,, 5	3	○	14	2●	,, 21	3	○	214	
,, 6	31	○	24		,, 22	231	○	4	
,, 7	32	⊙	1		,, 23		○	1234	
,, 8	⅘3	○		1●	,, 24	4	○	23	1●
,, 9	41	○	23		,, 25	421	○	3	
,, 10	4	○	123		,, 26	42	⊙	1	
,, 11	421	○	3		,, 27	431	○	2	
,, 12	432	○	1		,, 28	43	○	21	
,, 13	431	○	2		,, 29	4231	○		
,, 14	43	⊙	1		,, 30	4	○	13	2●
,, 15	2431	○			,, 31	4	○	23	1●
,, 16		⊙	243						

The following satellite phenomena are visible at Greenwich, all in the morning hours:—$1^d\ 3^h\ 30^m$ I. Oc. R.; $14^d\ 3^h\ 59^m\ 51^s$ I. Ec. D.; $16^d\ 2^h\ 30^m$ I. Tr. I., $3^h\ 36^m$ I. Sh. E.; $21^d\ 3^h\ 44^m$ II. Tr. I.; $23^d\ 3^h\ 11^m$ I. Sh. I.; $24^d\ 3^h\ 55^m$ I. Oc. R.; $28^d\ 3^h\ 47^m$ II. Sh. I.; $31^d\ 2^h\ 16^m\ 33^s$ I. Ec. D.

The Northward motion of Jupiter will make this year's opposition (which occurs on September 17th) more favourable for European observers than those of the last four years, in which it has been very low down.

SATURN is an evening star in Gemini. Is now approaching conjunction with the Sun. 2½° South of Mercury on 31st. Polar semi-diameter 8″. Major axis of ring 38″, minor 17″. Angle P−6°·2.

The Satellite positions are not given, owing to the planet's proximity to the Sun.

URANUS is a morning star, but badly placed. In quadrature with Sun on 8th. Near Moon on 6th, 7^h *m*.

NEPTUNE is an evening star in Cancer; diameter 2″.

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near May, 1915, are included. The lists in recent months may also be consulted (see Table 23).

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
Mar.—May ..	263	+ 62	Rather swift.
Apl. 19 May 9	201	+ 8	Slow.
Apl.—May ...	193	+ 58	Slow, yellow.
Apl.—May ...	296	0	Swift, streaks.
May 1-6 ..	338	− 2	Aquarids, swift, streaks.
,, 7 ...	246	+ 3	Slow, bright.
,, 11-18 ...	231	+ 27	Slow, small.
,, 30 to Aug	333	+ 28	Swift, streaks.
May—June ...	280	+ 32	Swift.
May—July ...	252	− 21	Slow, trains.
,, 18 to 31...	245	+ 29	Swift, white.

The May Aquarids are of special interest from their association with Halley's Comet. Accurate observations of their paths are desirable.

TABLE 23. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension. h. m. s.	Declination. ° ′	Magnitudes.	Period. d.	Date of Maximum.
T Camelop.	4 31 48	+65 59	7·0 to 13·5	370	1915—Apr. 19
R Aurigae	5 10 25	+53 30	6·5 to 13·3	448	,, Apr. 4
R Comae	11 59 54	+19 16	7·3 to 14·6	362	,, June 1
R Serpentis	15 46 47	+15 23	5·8 to 13·5	357	,, May 2
RU Herculis	16 6 41	+25 17	7·0 to 14·2	483	,, May 16

Night Minima of Algol $1^d\ 0^h\cdot4\ m$, $3^d\ 9^m\cdot2\ e$, $18^d\ 5^h\cdot3\ m$, $21^d\ 2^h\cdot1\ m$, $23^d\ 11^h\cdot9\ e$, $26^d\ 8^h\cdot7\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.
Principal Minima of β Lyrae $5^d\ 9^h\ m$, $18^d\ 7^h\ m$, $31^d\ 5^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.

TABLE 24. Occultations of Stars by the Moon visible at Greenwich.

Date. 1915.	Star's Name.	Magnitude.	Disappearance. Time. h. m.	Disappearance. Angle from N. to E. °	Reäppearance. Time. h. m.	Reäppearance. Angle from N. to E. °
May 1 ...	4 Scorpii	5·6	1 45 *m*	57	2 35 *m*	329
,, 2 ...	WZC 1098	6·7	—	—	3 28 *m*	247
,, 3 ...	BAC 6127	4·7	0 30 *m*	108	1 38 *m*	252
,, 7 ...	WZC 1466	7·1	—	—	3 11 *m*	182
,, 9 ...	13 Piscium	6·5	2 53 *m*	354	3 16 *m*	309
,, 16 ...	BAC 1754...	5·7	7 50 *e*	97	8 46 *e*	278
,, 16 ...	BD+26° 884	6·8	9 6 *e*	179	—	—
,, 24 ...	WZC 802	7·1	9 34 *e*	100	—	—
,, 26 ...	WZC 849	7·0	0 52 *m*	94	—	—
,, 27 ...	WZC 965	7·2	11 15 *e*	41	—	—
,, 31 ...	Lacaille 7849	7·0	—	—	1 36 *m*	222

From New to Full disappearances occur at the Dark Limb, from Full to New reäppearances.

POLLARDS.

THE making of pollards ensures a supply from time to time of long poles suitable for fencing and other purposes, in much the same way as they are obtained in the underwood of copses. There is this advantage, however, about the former method, that pollards can be grown in odd corners, along the sides of streams (as in the case of willows), or in hedgerows. Where we find pollards in woods or scattered about common land, it seems likely that they were produced in connection with common rights, and that they were cut legitimately or otherwise by cottagers who were not supposed to touch the forest trees.

There is no doubt but that old pollards which have been left alone for many years, such as those at Burnham Beeches, become very picturesque, but their conservation is a matter of difficulty. The old trunk becomes hollow, and often a mere shell has to support a large number of solid branches (see Figure 93), each of which may weigh several tons. Our illustrations (see Figures 93 to 97) show how, in the slightest wind or in the still air, the pollards may break up, and many of them have to be cut somewhat drastically in order to save them at all.

FIGURE 93.

A Beech Pollard, showing the large mass of heavy branches, which if not removed will destroy the hollow trunk.

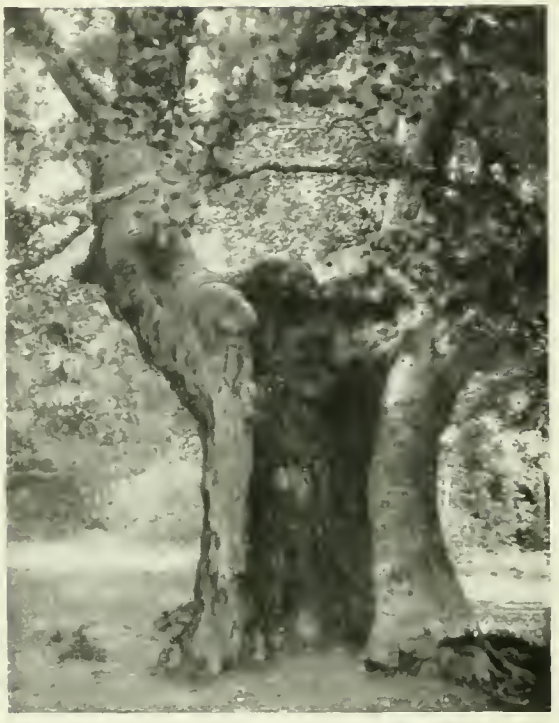


FIGURE 94.

A Pollard that has lost one side, and to preserve which the limbs must be lopped.

FIGURE 95.

Wires and prop to prevent the Pollard from breaking up.

Figure 96.

Limb of a Pollard that has been broken off by the wind.

Figure 97.

A Pollard cut back to preserve it from utter ruin.

STONYHURST COLLEGE OBSERVATORY.

By FRANK C. DENNETT.

THE Annual Report of this institution for 1914 has just been issued by its able Director, the Rev. Walter Sidgreaves, S.J., F.R.A.S. The year has proved remarkably mild and cloudy. The mean barometric pressure was 0·041 inch below the average, and the mean temperature 1°·5 above the average. The rainfall proved to be 3·113 inches in excess of the mean quantity. Only one "record" seems to have occurred: January 8th had the heaviest fall of rain—2·074 inches—for a January day that has occurred

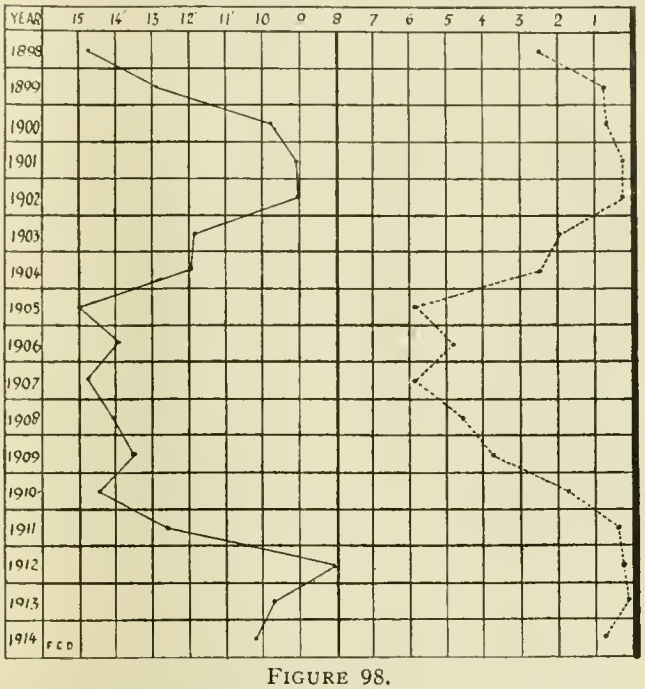


FIGURE 98.

Magnetic Mean Declination Range. Mean Daily Spot Area.

during the previous sixty-seven years. May was the only month with a mean temperature below the average, and cloudiness is shown by the fact that the total hours of sunshine registered are three hundred and twenty-eight less than the average of the past thirty-four years. September gave a record of thirty sunny days, with 176·5 bright hours. The wind record is below the annual average to the extent of two thousand three hundred and eighty-six miles. The strongest gale reached only forty-four miles in the hour on February 22nd. The rainfall of the year shows an excess of three inches above the usual record. January, March, May, July, September, November, and December each yielded a rainfall above the average, especially the last two, which together had a rainfall of 14·46 inches, or 5·392 inches in excess of the mean. In August and October little over half the usual amount fell. Magnetic records appear to be missing on five days—January 5th to 8th and June 29th. Of the remainder, one hundred and twenty-two are marked as calm, two hundred and ten as small, and twenty-five as moderate; three days only are marked as greater, April 5th and 6th—when the fine sun-spot group No. 5 was crossing the central meridian—and September 27th; but no very great disturbances occurred. The magnetic conditions during the year have been remarkably quiet. Solar observations were made on two hundred and seventeen days, and drawings made on one hundred and thirty-three: only nineteen of these showed faculae, and one hundred and fourteen spots and faculae. The mean disc area of spots (in units of one five-thousandth of the visible surface) appears at 0·82, and the mean daily range of the magnetic declination (in minutes of arc) at 10′·2. These are included in the diagram constructed by the writer (see Figure 98), showing the variations since 1898, as given in the Stonyhurst reports, and are worth study.

The present report is additionally interesting in that it gives a record of the expedition organised by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies to Hernösand, in Sweden, to observe the total eclipse of the Sun, August 21st, 1914. Originally it was arranged for Professor A. Fowler and Father Cortie, accompanied by Major Hills and Father O'Connor, with Dr. Fowler's assistant, to go to Kiev, in Russia. The Russian Government, however, would not at first grant the necessary permission to the Jesuit Fathers. This objection, however, was withdrawn later at the intervention of Dr. Backlund, the Imperial Astronomer at Pulkova, but by good fortune the news did not reach the party. The outbreak of War would have stopped the party at Riga, as, indeed, was the case with Professor Fowler. Had they reached Kiev the clouds would have prevented observations. As it was, they, through the good offices of Professor B. Hasselberg, found a capital site, with exceptional conveniences, at Hernösand, in a field at the rear of the Technical School. Moreover, on the day of the eclipse they were favoured with fine skies. The equipment was good, and the observations successful. One photograph of the corona, taken with the twenty-foot objective—four inches aperture—is given in the report. A study of the rays in the corona makes it apparent that some of them are due to the great sun-spot (No. 24 in the "KNOWLEDGE" List). The corona was generally of the minimum type, the beautiful short radiations around the poles, the arc extending for 75° about the North and 65° about the South Pole. A long "fish-tail" extended away from the western limb, and spreading rays of the "intermediate" type from the eastern. Eight prominences appear on the plates, some being fine ones. Like other observers, they found what is usually known as the "characteristic coronal radiation" at wave-length 5303 to be barely traceable on the photographic plates. This appears to be weak at the times of sun-spot minimum, as it was faint in 1900. For more minute details the reader is referred to the report itself, which is well worthy of study.

REVIEWS.

BIOGRAPHY.

Life of Sir John Lubbock (Lord Avebury).—By HORACE G. HUTCHINSON. 2 volumes. 338 and 334 pages. 2 illustrations in each volume. 8¾-in. × 5½-in. (Macmillan & Co. Price 30/- net.)

If Mr. Hutchinson is not concerned with apportioning to Lord Avebury his precise niche in Fame's temple, the volumes before us bring home to the reader the fact that the niche, wherever it may be situated, must be a very important one.

Mr. Hutchinson mentions more than once the comment that bankers considered Lord Avebury to be a good scientific man, while men of science looked upon him as a good banker; and, though we agree that the biography "disposes for ever of that ill-considered criticism," it may be well to look for a moment at the reasons which may have led to it. It is not recorded, apparently, who is responsible for the epigram, but we should imagine that it was not made by a banker.

Scientific men who specialise are prone to the very human

ailment known as " getting into a groove," and look askance upon versatility which Lord Avebury possessed to a very remarkable degree. They seem to forget the necessity of broadmindedness, and fail to appreciate that he who makes known to the world what is being done in science is doing a very important work, with the help most probably of talents which they do not themselves possess. Science is ignored far too greatly by the powers that be and by the commercial classes in this country; and the mere fact that a man who has distinguished himself as a financier, a politician, and an administrator has also made a mark in science is of very great value to science.

At one time there was a tendency to belittle Lord Avebury's scientific work because some of the observations which he used were carried out by others. Nobody objects to the fact that an architect does not with his own hands build the houses which he plans, or that a modern sculptor puts only the finishing touches to the marble. Many scientific men have become famous through using the observations of others which they did not originate, and many a zoölogical professor has added his name to that of a demonstrator on the title pages of a paper written by the latter to the mutual advantage of both.

Lord Avebury, who wasted very little of his time, planned out the work which he wanted done, and it was by delegating part of this that he was able to do so much.

Mr. Hutchinson's book recalls that, besides being a banker, Lord Avebury was a member of Parliament, where he played no small part; was Chairman of the London County Council, president of nearly all the scientific societies at one time or another, Warden of Birmingham University, and Rector of St. Andrews; but even the two volumes before us are not sufficient to record a very great deal of the useful work which Lord Avebury did. We are reminded of his support of Darwin, and that we owe the terms " palaeolithic " and " neolithic "—now household words in science—to Lord Avebury. Educational movements in this country have profited by the help of Lord Avebury, which he was ever ready to give, and not the least of his endeavours was that to preserve something of the beauties and antiquities of our land.

The biography of Lord Avebury strengthens one's feeling gained from the lives of other famous men, whose career at school was cut short, that our system of education is not calculated to encourage individuality, and that those who go through the ordinary school course, and make their way in the world, succeed in spite of it. In conclusion, we may say that every thinking person would be the better for carefully reading Sir John Lubbock, Lord Avebury's life.

W. M. W.

CHEMISTRY.

Photo-Chemistry.—By S. E. Sheppard, D.Sc. 461 pages. 47 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 12/6.)

This is the latest addition to the series of text-books of physical chemistry edited by Sir William Ramsay, and it fills a distinct gap in chemical literature. Most of the previous treatises on the subject have dealt, in the main, with the reactions of light in its special adaptation of photography, and there was no convenient handbook discussing the other aspects of photo-chemistry. The boundaries of this division of chemistry are not well-defined, for some of the radio-active phenomena also fall within its scope, and are therefore briefly touched upon in this book. It has been the author's aim, not to describe all the known photo-chemical changes, but rather to discuss typical instances at sufficient length to illustrate the theory. The book thus fulfils the true function of a practical handbook, of throwing sidelights upon the meaning of new phenomena met with by the student, and full references to original papers are given on every page. The branches of the subject discussed include the measurement of quantities of light, the absorption of light, dynamics of photo-chemical change, special photo-chemistry, genesis of light in chemical change, and organic photo-synthesis (including the chemistry of chlorophyll). It is a book that should find a warm welcome from the chemist, the photographer, and the botanist with a knowledge of chemistry.

C. A. M.

GEOGRAPHY.

A Little Book on Map-Projection.—By M. Adams. 108 pages. 41 figures. 8½-in. × 5½-in.

(George Philip & Son. Price 2/- net.)

To the non-mathematical student of geography no part of the subject presents so many difficulties as the study of map-projection. Although several excellent books on the latter subject have been written, the treatment in these is, without exception, mathematical, and hence incomprehensible to many. For this reason alone this book by Miss Adams should be found exceedingly useful. The subject is treated in a strictly non-mathematical fashion, and even the simple trigonometric ratios only appear in some non-essential paragraphs. As is to be expected, the arrangement of the subject-matter is not strictly logical, but this does not in any way diminish the lucidity of the explanations.

The first part of the book treats of the principles of map-projection, and of the various geometrical concepts connected therewith; while in the second part is given a description of the types commonly in use. Sundry mathematical notes on certain of the latter are given in an appendix. A number of diagrams illustrative of the different projections are of much assistance in the comprehension of the descriptive parts (the diagram of the gnomonic projection is a trifle confusing, however.) In view of the great development of modern geographical teaching, this book should prove valuable, both to teachers and students, and it can be recommended as an attractive presentation of a subject usually considered somewhat " dry."

A. S.

FORESTRY.

Elements of Forestry.—By F. F. Moon, Professor of Forest Engineering, and N. C. Brown, Professor of Forest Utilisation, New York State College of Forestry, Syracuse, N.Y. 392 pages. 8¼-in. × 6½-in.

(New York: John Wiley & Sons. London: Chapman & Hall. Price 8/6 net.)

We have watched with interest the growth of State forestry in the United States from its beginning under Dr. F. B. Hough, in 1876, to the present day. In 1882 Dr. Hough published a work with the same title as that now before us—an excellent work, but based necessarily on the experience of European countries. Not till 1891 was President Harrison empowered to reserve national forest land; but the thirteen million acres that he set aside, to which President Cleveland added twenty-two million, rose under President Roosevelt to one hundred and ninety-four and a half million acres, " under the control of an efficient, non-political, technically trained " Forest Service. Deservedly, therefore, is this book dedicated to the last-named ex-President as the man who " aroused the American people to the importance of forestry as a national issue." This importance is categorically demonstrated by the authors under the following four reasons :—

" *First.*—We are cutting our timber about three times as fast as it is growing.

" *Second.*—Our *per capita* consumption is unnecessarily high, being two hundred and sixty cubic feet against forty cubic feet in Germany and twelve cubic feet in Great Britain.

" *Third.*—Our per-acre production has sunk so low under the poor forest management until it is only about one-fourth of the possible yield.

" *Fourth.*—Already the end is in sight for some species of timber, and the virgin supply of forest material in the

United States will be practically exhausted by the year 1950."

This being so, it was clearly opportune that an up-to-date textbook on the general subject should appear; and the present work is in marked contrast to Dr. Hough's book of 1882, in that it is the exposition of a complete system of forestry of purely national growth and character. Although, of course, the general principles of the physiology of the tree, of what the authors term "silvics," and even of sylvicultural management, forest protection, mensuration, and technology, are the same everywhere, the application of these principles to American species and American conditions gives a thoroughly local colour to the entire work. These principles, including also those of wood utilisation, wood preservation, and forest finance, are so clearly set forth as to render the book useful to anyone concerned with timber or forestry in any land; while the map and the second half of the text give a more succinct and intelligible account of the forest regions of the United States than we remember to have met with anywhere else. A tolerably full glossary of technical terms is given; but the English reader might be glad of an explanation of a good many words, such as "burlap," "duff," "excelsior," "kerf," "ross," and "tierce," which find no place in it. As, however, the title-page bears the (to us) unusual inscription, "First Edition First Thousand," we may well look forward to seeing all such terms explained in some future reissue. A bibliography—mainly of United States Government publications—is added to each chapter; and the apparent ambiguity of such names as Yellow, Hard or Norway Pine, Red Cedar, and so on, is obviated by an appendix in which the scientific names are given.

G. S. BOULGER.

LOGIC.

Logic: Deductive and Inductive.—By Carveth Read, M.A. 417 pages. 7½-in. × 5-in.

(Alexander Moring. Price 6/–)

This, the fourth edition of Mr. Read's "Logic," has been completely revised, and some new sections have been added. In the main, the author follows Mill, though not without occasionally criticising his position. The first part of the book, dealing with deductive logic, seems very satisfactory on the whole, the author's presentation being straightforward and clear, though the determination of the nineteen moods of the syllogism and their reduction to the first figure are treated rather briefly.

The latter part of the book, dealing with inductive logic and allied topics, is of more questionable value, the writer, it seems to me, lacking something of Mill's precision. Some of the sections are, indeed, excellent, such as those on "The Canons of Direct Induction" and "Definition of Common Terms." But the defects in the chapters on "Transition to Induction" and "Causation," and elsewhere, are so serious that one hesitates to recommend the book to students. In metaphysics, "causation," and consequently "explanation," has an entirely different connotation from that with which it is used in logic and the natural sciences. It is very necessary, therefore, in a treatise on logic to make this difference quite plain, especially as the common use of these words has a vague idea of their metaphysical meanings behind it. Now, Mr. Read not only fails to do this, but habitually writes of "physical" causes as though they were "efficient" causes as well. Great stress, moreover, is laid upon the principles of conservation of matter and conservation of energy. But to base logic on the principles of physical science, which themselves must seek their justification in logic, is surely to argue in a circle; and the danger of this particular circle is the more evident now that the principle of the conservation of matter has been called in question. Moreover, such a fallacious statement as ". . . all Times and all Spaces are commensurable, although in certain relations of space (as π) the unit of measurement must be infinitely small," is surely remarkable in a book on logic. What, in fact, does the necessity for an infinitely small unit imply but that the things so needing to be measured are incommensurable?

In the chapter on "Hypotheses" the author appears to be straining after an unattainable ideal. As Poincaré has pointed out, every phenomenon permits of infinite hypotheses valid in the scientific sense of the term. The pragmatic criterion is the only one that offers us any escape from this burden of infinity; and using that criterion we should adopt that hypothesis which is simplest, and therefore most useful. There is no hint, however, of anything of this in Mr. Read's treatment of the subject. These defects are the more regrettable because of the commendable quality of much else in the book. There are thirteen pages of examination questions at the end, but no index.

H. S. REDGROVE.

PHYSICS.

The Principle of Relativity.—By E. Cunningham, M.A. 221 pages. 8¾-in. × 5½-in.

(Cambridge University Press. Price 9/- net.)

The subject of this treatise has received a large degree of attention since Einstein, ten years ago, brought the theory of Relativity into prominence. The doctrine itself may be regarded as teaching the futility of all experimentation with a view to determining the motion of matter with respect to the ether, if one is assumed to exist. If one does not postulate any ether, then the principle resolves itself into a denial of the possibility of determining absolute velocity in a physical sense. Although beginning with a negative hypothesis, the results are by no means limited to negations. As the author unfolds the results of the theory, one is reminded of the consequences flowing from the denial of a perpetual motion, or of the statement that heat will not of itself move from a place of lower to a place of higher temperature.

The author is a well-known mathematician, a fellow and lecturer of St. John's College, Cambridge, and it is therefore natural to expect a highly mathematical treatment of the subject; but the mathematical part has been compressed so as to leave room for very clear accounts of the optical and electrical experiments bearing on the subject. In fact, a large portion of the work will be read with ease and pleasure by the non-mathematical reader. The usual table of contents is reinforced by a very lucid and well-written summary of each chapter, which will be especially useful to serious students. The references given to the chief original papers will form a very welcome guide to the voluminous literature of the subject.

J. H. V.

Introduction to Physical Metallurgy.—By Walter Rosenhain, B.A., D.Sc., F.R.S. 368 pages, 53 figures in the text. 88 figures on 32 plates. 8½-in. × 5½-in.

(Constable & Co. Price 10/6 net.)

The arts of winning metals from their ores, and of fashioning these metals into weapons and implements, have been practised from prehistoric times, but the systematic study of the internal constitution and physical properties of metals and alloys—the science of Physical Metallurgy—can be said to date only from 1864, when Sorby first noted the striking similarity in the nature of the microstructures of steel and minerals. In fact, nearly all the names associated with this branch of science are those of men still alive, and actively conducting investigations at the present day.

This state of things naturally implies a large output of original work which only a fortunate few have time to follow closely. It implies, moreover, special methods of investigation, and even a special nomenclature, which make it difficult, or even impossible, for those not familiar with

the science to understand the papers in which the results of investigations are described.

The value of a book, therefore, which, while not overburdened with detail, yet gives a clear survey of the methods of investigation and of the results so far achieved, cannot easily be overrated; and Dr. Rosenhain is to be congratulated on having given us in the present volume just such a book. The microscopic examination of metals, from the selection and preparation of the specimen to the interpretation of the structures revealed, is discussed with the sure touch of one with considerable experience, whilst the lucidity with which the construction of constitutional diagrams is described, and several typical alloy systems—and notably the iron-carbon system — are discussed, reveals the born teacher. The second half of the book is devoted to "the properties of metals as related to their structure and constitution." In this part are discussed the mechanical testing of metals, the effect of strain, and the thermal and mechanical treatments of metal. The final chapter deals with "Defects and Failures in Metals and Alloys." The book is illustrated with numerous excellent reproductions of photomicrographs, but the omission of all details as to subject and magnification on the plates themselves, and in most cases of the page number of a given plate in the text, is a constant source of annoyance to the reader, necessitating repeated references to the list of plates at the beginning of the book. It is unfortunate also that the chapter on "The Thermal Study of Metals and Alloys" should be marred by several typographical errors. With these exceptions, however, we have nothing but praise for a book which can be unreservedly recommended to all who are beginning the study of physical metallurgy, and to those who, as manufacturers or users, are chiefly interested in the properties of metals from the "practical" side.

T. S.

POND LIFE.

Pond Life.—By E. C. Ash. 92 pages. Numerous figures in the text. 6½-in. × 4½-in.

(T. C. & E. C. Jack. Price 6/- net.)

Ponds and puddles have a fascination for the young; and, if some knowledge of the many interesting creatures which live their life in small volumes of water is acquired, the interest remains or increases in after-life. Mr. Ash's little work, which is one of the series produced at the cost of sixpence by Messrs. Jack, under the title of "The People's Books," gives an account of the inhabitants of our ponds. It is written in a light, not to say even jocular, vein, and gives a good idea of what the enthusiast may expect to find. Microscopic plants, infusoria, insects, spiders, mites, aquatic worms, and amphibians are among the subjects which are considered. We do not like to see Latin names printed in ordinary Roman type, and zoölogists do not use capital letters for specific names; still these are matters which will not affect the general reader, who will find much that is attractive in "Pond Life."

W. M. W.

NOTICES.

THE FLEMISH SYSTEM OF POULTRY-KEEPING.—*Country Life* asks us to announce a series of articles which will shortly appear in its columns by Madame Albert Jasper on "The Flemish System of Poultry-keeping."

THE "LONDON" MICROSCOPE.—We have received from Messrs. R. & J. Beck a leaflet showing three models of their "London" microscope, with the various objectives and condensers suggested for use with them, the whole being set out in such a way, with each item priced separately, that anyone can tell at a glance what any particular outfit would cost.

COCKROACHES AT THE ZOÖLOGICAL GARDENS.—On February 23rd, at the meeting of the Zoölogical Society of London, Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited mounted examples of three species of Cockroach—*Periplaneta americana*, *P. orientalis*, and *Phyllodromia germanica*—all of which had established themselves in different houses in the Society's Gardens, and stated his wish that some naturalist would endeavour to work out the causes of the selective distribution of these insects.

PHOTO-MICROGRAPHY.—At the end of the course of lectures on Photography which Mr. E. Senior is delivering at the South Western Polytechnic Institute he will give six practical demonstrations on Photo-micrography on Monday evenings, from 7.30 to 9.30, beginning on May 3rd. At these demonstrations special attention will be given to the photographing of etched surfaces of metals and alloys (metallography), but the course will also be arranged to suit the requirements of students of geology, botany, and so on, and of those wishing to use their own microscopes to obtain photographic records of objects. It is advisable that students joining this course should possess an elementary knowledge of photographic manipulation. The fee for the course is 2/6.

A NEW PHOTOGRAPHIC PLATE.—A new plate has been introduced by Ilford, Limited, for the use of those engaged in Press-photography: it combines extreme rapidity with quick development, quick fixation, and quick drying, and should prove valuable to those photographers who practise this class of work. It is supplied at popular prices, and a sample for testing purposes will be forwarded post free upon receipt of a professional card. The plate is known as the "Ilford Press plate."

BOXWOOD FROM SOUTH AFRICA.—Our chief supplies of boxwood for many years have been drawn from the countries bordering on the Black and Caspian Seas. These supplies have now been cut off, so that boxwood is difficult to obtain and expensive to buy. The Imperial Institute has recently examined the wood of *Buxus Macowani* from South Africa. Several firms using boxwood have also tested it, and the general opinion being favourable, the Imperial Institute has suggested to the Government of the Union of South Africa that it would be well to place a trial shipment of this South African boxwood on the London market.

GLASS APPARATUS FOR EDUCATIONAL PURPOSES.—Sir Alexander Pedler has sent us, on behalf of the British Science Guild, a joint report of the Education and the Technical Education Committees on the provision of glass apparatus for educational purposes. The Joint Committee has been endeavouring to obtain assurances of support for British makers of educational glassware after the war as well as now, and has also collected information respecting the principal types and size of glass apparatus which is in greatest demand. Seventy-one per cent. of the head masters of the schools represented on the Head Masters' Conference have authorised their science staffs to purchase, as far as possible, only British-made glass apparatus during, and for a period of three years after the conclusion of, the war. In other directions fewer definite replies have been received, owing to the fact that committees and boards have to be consulted before an answer can be given. Another report deals with the manufacture of optical instruments, and we most heartily endorse the suggestion that the Government should undertake the necessary research that must be carried out before optical glass suitable for microscope and photographic lenses, equal to that made at Jena, can be produced in England.

PRUDENTIAL ASSURANCE COMPANY, LIMITED.

Chief Office: HOLBORN BARS, LONDON.

Summary of the Report presented at the Sixty-sixth Annual Meeting held on 4th March, 1915.

ORDINARY BRANCH. The number of policies issued during the year was **65,751**, assuring the sum of **£5,318,843**, and producing a new annual premium income of **£424,353**. The premiums received during the year were **£5,035,625**, being an increase of **£115,107** over the year 1913. In addition, **£10,315** was received in premiums under the Sickness Insurance Tables. The claims of the year amounted to **£4,014,658**. The number of deaths was **9,351**. The number of endowment assurances matured was **24,966**, the premium income of which was **£136,735**.

The number of policies in force at the end of the year was **922,505**.

INDUSTRIAL BRANCH. The premiums received during the year were **£8,176,202**, being an increase of **£301,746**. The claims of the year amounted to **£3,373,850**, including **£393,360** bonus additions. The number of claims and surrenders, including **6,731** endowment assurances matured, was **392,883**. The number of free policies granted during the year to those policyholders of five years' standing and upwards, who desired to discontinue their payments, was **103,514**, the number in force being **1,947,556**. The number of free policies which became claims during the year was **46,264**.

The total number of policies in force in this Branch at the end of the year was **20,085,010**; their average duration exceeds thirteen years.

The assets of the Company, in both branches, as shown in the balance sheet, are **£91,202,344**, being an increase of **£4,209,341** over those of 1913.

The outbreak of hostilities in August last placed upon the Directors the grave responsibility of deciding what charge, if any, should be made to policyholders on active service. After careful consideration it was decided to charge no extra premium in respect of existing policies on the lives of those engaging for the period of the war, and in respect of existing policies on the lives of other members of the regular forces it was decided that £250 of assurance on any life should be exempted from the payment of extra premium.

In the Ordinary Branch a reversionary bonus at the rate of £1 10s. [illegible] the original sums assured has been [illegible] since the year 1875.

In the Industrial Branch [illegible] on policies of over five years' duration which [illegible] of endowment in the 5th of March 1915, to the 2nd of March 1916 inclusive, as follows:

Premiums Paid Per	Bonus Addition to Sum Assured
5 years and less than 10 years	£2 10s. per cent.
10 " " 15 "	£5 "
15 " " 20 "	£5 "
20 " " 25 "	£7 10s. "
25 " " 30 "	£10 "
30 " " 35 "	£12 10s. "
35 " " 40 "	£15 "
40 " " 45 "	£20 "
45 " " 50 "	£30 "
50 " " 55 "	£40 "
55 " " 60 "	£50 "
60 and upwards	£60 "

The six Prudential Approved Societies [illegible] 1911 have had an important work during the year, [illegible] increase. Since the commencement of the Act to 31st December [illegible] exceeding £3,000,000 to the members at their own homes.

Balance Sheet of the Prudential Assurance Company, Limited, being the Summary of both Branches, on the 31st December, 1914.

LIABILITIES.

		£ s. d.
Shareholders' capital		1,000,000 0 0
Life assurance fund—		
Ordinary Branch	£47,024,190 5 8	
Sickness insurance fund	13,562 8 9	
Life assurance fund—		
Industrial Branch	40,649,318 9 8	
		87,687,071 4 1
Investments reserve funds		1,750,000 0 0
Courts (Emergency Powers) Act Reserve		300,000 0 0
Claims under life policies intimated and in course of payment		233,518 0 7
Annuities due and unpaid		3,171 13 4
Balance of bonus under life policies reserved for distribution		228,582 15 10
		£91,202,343 13 10

ASSETS.

	£ s. d.
Mortgages on property within the United Kingdom	8,882,496 5 4
Mortgages on property out of the United Kingdom	336,449 2 9
Loans on parochial and other public rates	13,412,347 14 8
Loans on Life interests	1,193,287 0 11
Loans on Reversions	96,502 18 3
Loans on stocks and shares	76,385 2 0
Loans on Company's policies within their surrender values	3,221,385 7 9
Loans on Personal security	*Nil*
Loans to Educational institutions secured on income, etc.	43,969 19 1
Investments :—	
Deposit with the High Court (£24,400 2½% Consolidated Stock)	17,568 0 0
Carried forward	£27,280,391 10 9

ASSETS

	£ s. d.
Brought forward	27,280,391 10 9
Investments *continued*	
British Government securities	1,413,368 1 5
Bank of England stock	143,117 2 10
Municipal, and county securities—United Kingdom	1,682,752 10 7
Indian and Colonial Government securities	4,621,551 12 10
Colonial provincial securities	1,371,547 15 11
Indian and Colonial municipal securities	3,577,816 8 5
Foreign Government securities	5,411,862 18 11
Foreign provincial securities	789,465 10 11
Foreign municipal securities	4,115,813 0 6
Railway and other debenture and guaranteed and preferential stocks and shares and Canadian Pacific Railway Co. 4% Perpetual Debenture Stock	21,247,943 14 5
Railway and other preferred and guaranteed stocks and shares	3,193,674 17 2
Railway and other ordinary stocks and shares	2,865,148 2 6
Rent charges	605,472 4 2
Freehold ground rents and Scotch feu duties	4,763,452 6 6
Leasehold ground rents	9,143 11 7
House property	4,200,467 19 11
Life interests	34,626 14 6
Reversions	1,338,434 10 7
Agents' balances	6,647 16 0
Outstanding premiums	627,723 11 8
Outstanding interest and rents	115,010 13 4
Interest, dividends and rents [illegible]	522,743 1 0
Bills receivable	Nil
Cash on deposit	20,000 0 0
In hand and in the hands of bankers	1,241,167 17 5
	£91,202,343 13 10

The values of the Stock Exchange securities are determined, under the Regulations of the Companies (Accounts and Audit) Act, 1911, by the middle market prices on 31st December, 1913, subsequent purchases being taken at cost prices. [illegible] than provided for by the Investments Reserve Funds.

We certify that in our belief the Assets set forth in the Balance Sheet [illegible] with [illegible] value stated therein less the Investments Reserve Funds taken into account. No part [illegible] class of business to which it is applicable.

A. C. THOMPSON, *General Manager.*

J. BURN, *Secretary.*
C. F. MAY, *Secretary.*

THOS. J. DEWEY
W. T. LANCASTER
E. SCHOLFIELD

We report that with the assistance of the Chartered Accountants as stated [illegible] explanations that we have required, and in our opinion such accounts are correct and [illegible] of the Company's affairs according to the best of our information and the explanations [illegible] fund has been applied directly or indirectly for any purpose other than the class of business to which it is applicable.

PHILIP SECRETAN
W. H. NICHOLS

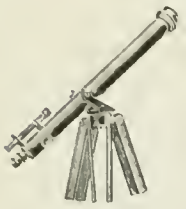
We have examined the Cash transactions (receipts and payments) affecting the accounts of the Company [illegible] 31st December, 1914, we find the same in good order and properly vouched. We have also examined the Deeds and Securities [illegible] Assets in the above account, and we certify that they were in possession and safe custody at the 31st December, 1914.

16th *February*, 1915.

DELOITTE, PLENDER, GRIFFITHS & CO.

CLARKSON'S SECOND-HAND OPTICAL MART.

TELESCOPES.



4½-in. **Wray**, mounted on massive oak lath stand with stretchers, horizontal and vertical movements by Hooke's joint, slow motions, large finder, 4 astro. and 1 day eyepieces .. £40 0 0

4-in. full. **Negretti & Zambra** altaz., finder, 1 day, 3 astros., in case 25 0 0

3-in. **Baker**, altaz., horizontal and vertical motions, finder, day and 2 astros. .. 17 10 0

3½-in. **Casella** altaz., 1 day, 2 astros. .. 15 0 0

3-in. **Steward**, on altaz. with equatorial (undivided circles), 1 day, 2 astros. .. 11 10 0

3-in. **Wood**, 1 astro. and 1 day eyepieces .. 4 0 0

Many others. Also Eyepieces, Finders, Diagonals, etc.

MICROSCOPES.

Watson "Bactil," 2 eyepieces, 1-in., 1/6, and 1/12 oil immersion objectives, triple nosepiece, universal condenser .. 10 0 0

Watson "Edinburgh H," 2/3, 1/6, 1/12 o.i., eyepieces, triple nosepiece, and Abbe 15 15 0

Beck Large "London," 3 eyepieces, 2/3, 1/6, and 1/24 oil immersion objectives, triple nosepiece, spiral Abbe and iris, mechanical stage, as new .. 14 14 0

Baker "D.P.H." No. 1, 2 eyepieces, Leitz 3 and 7 objectives, triple nosepiece, Abbe condenser 13 15 0

Watson "Fram," eyepiece, spiral, Abbe and iris, double nosepiece, 2/3 and 1/6 .. .. 6 15 0

Leitz IIb, eyepiece, 3 and 7 objectives, double nosepiece, spiral Abbe and iris 6 10 0

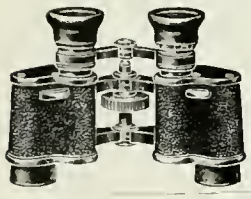
Beck Small "London," spiral, Abbe and iris, double nosepiece, 2/3 and 1/6 6 10 0

Swift "Discovery," eyepiece, 2/3, 1/6, double nosepiece 5 15 0

Beck "Star," sliding coarse and micrometer fine adjustments, 1 eyepiece, 2/3 and 1/6 objectives, double nosepiece, spiral Abbe and iris, no case 3 5 0

Many others. Also Objectives (a large stock by all the leading makers), Eyepieces, Double and Triple Nosepieces, Condensers, Lamps, Spectroscopes, Microtomes, Cabinets, etc.

PRISM BINOCULARS



BY ROSS, ZEISS, GOERZ, etc., FOR SALE AND WANTED.

338 HIGH HOLBORN
(Opposite Gray's Inn Road).
LONDON.

MICROSCOPY.

SPECIALLY ATTRACTIVE SLIDES FOR POPULAR EXHIBITION *OR* STUDY.

Zoology, Marine and Freshwater.—Unique preparations, *without pressure*, in their natural form and beauty for Dark Ground (or transparent). *Zoophytes*, *Medusæ*, *Polyzoa*, with their glorious array of tentacles; *Holothurians* with wheel plates, etc.; a series of the curious *Salpæ* and other *Tunicates*; young *Gobies* developing in their eggs; the celebrated *Lancelet*; also the Radiolarian *Sphærozoum*, the "Volvox of the sea," etc., etc.

Insects and Parts.—Larva of *Plumed Gnat* (also for polariscope). Superb tongues of the rare *Sylvan Wasp* and *Hornet*, also piercing organs of the *Gadfly*, *etc.*, *etc.*

Special Cements, Forceps, Scissors, etc., etc., for Mounting and Dissecting.

SECOND-HAND INSTRUMENTS, OBJECTIVES, &c.
NEW LIST NOW READY.
Post free on request.

To Beginners.—Expert advice freely given on selection of suitable equipment; much time and needless expense can thereby be saved. Write or call.

WANTED. Microscopes, Objectives, etc., or whole Outfits purchased for Cash.

EXCHANGES MADE.

CLARKE & PAGE,
23, Thavies Inn, Holborn Circus, LONDON.

LIVING SPECIMENS FOR THE MICROSCOPE.

Volvox globator, Desmids, Diatoms, Spirogyra, Amœba, Actinophrys, Spongilla, Vorticella, Stentor, Hydra Cordylopohra, Stephanoceros, Melicerta, Polyzoa, and other forms of Pond Life, **1s.** per tube, with printed drawing, post free. Thomas Bolton, Naturalist, 25, Balsall Heath Road, Birmingham.

MINERALOGY AND GEOLOGY.

JAMES R. GREGORY & Co.,
Mineralogists, &c.,
Are in a better position than ever for supplying
Collections of Minerals, Fossils & Rocks,
As they have recently made Large purchases of material.
LISTS AS USUAL.
139, Fulham Road, South Kensington, S.W.
Telephone: Western 2841.
Telegrams: "Meteorites, London."

SECOND-HAND DEPARTMENT.

Microscopes, Telescopes, Spectroscopes, Binoculars, Surveying Instruments, &c.,

BY THE BEST MAKERS AT MODERATE PRICES.

Lists sent post free on request.

Scientific Instruments Bought, Exchanged and Sold on Commission.

JOHN BROWNING,
146 STRAND, and 72 New Oxford St., LONDON.

Telegrams: "AUKS," LONDON. Telephone 824 GERRARD.

ESTABLISHED 1760

Stevens' Auction Rooms,

38, KING ST., COVENT GARDEN, LONDON, W.C.

Every Friday at 12.30, Sales are held at the Rooms of Microscopes and Slides, Telescopes, Surveying Instruments, Electrical and Scientific Apparatus, Cameras and Lenses, Lanterns and Slides, Cinematographs and Films, in great variety, Lathes and Tools, Etc.

Goods may be sent for inclusion in early Sales. Settlements made one week after disposal.

Catalogues and all Particulars Post Free.

Valuations for Probate or Transfer, and Sales conducted in any part of the Country.

FOR ALL KINDS OF EDUCATIONAL

Mineral Material,

COMMON ORES, and SELECT CRYSTALLIZED SPECIMENS, at ALL PRICES.

G. H. RICHARDS & Co.,
Dealers in all kinds of British and Foreign Mineral Specimens.
PRICE LISTS FREE.
48 Sydney Street, Fulham Road, South Kensington London, S.W.

F. WIGGINS & SONS,

102, 103, 104, Minories, LONDON, E.

Contractors to H.M. Government.

MICA

FOR **LAMPS, STOVES, VENTILATORS, ELECTRICAL WORK** AND ALL PURPOSES.

Largest Stock in the World. Tel. No. 2248 Avenue.

JOHN KING,

Printer of "Knowledge."
Uxbridge, Southall, and Ealing,

Is favourably equipped for the **PRINTING** of Scientific Books, Brochures, Catalogues, &c., and will be pleased to submit estimates.

Address all Communications to
213, UXBRIDGE ROAD, EALING, LONDON, W.
'Phone: 1144 Ealing.

Binding Cases for Knowledge Volume, 1914.

IN BLUE CLOTH, WITH GILT DESIGN AND LETTERING. *1s. 9d. net each: by post, 2s.*

Knowledge Office: AVENUE CHAMBERS, BLOOMSBURY SQUARE, LONDON, W.C.

A most acceptable Gift at any time.

KNOWLEDGE VOLUME FOR 1914.

Containing **440 Pages** with **425 Illustrations**, many being Full Page Plates.
Bound in Blue Cloth, Gilt Design and Lettering, **15 -** net, post free within the United Kingdom.

Publishing Office: AVENUE CHAMBERS, BLOOMSBURY SQUARE, LONDON, W.C., or through any Bookseller.

WATSON'S MICROSCOPES

The best obtainable. British-made throughout.

EFFICIENT: Enable the worker to get the best out of his instrument.

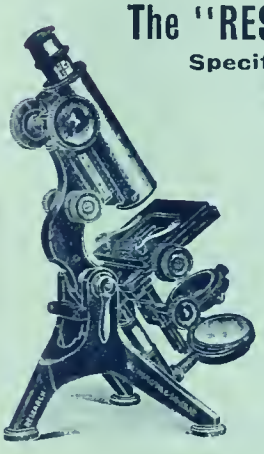
CONVENIENT: Every necessary movement is embodied.

STABLE: With either tripod or horseshoe foot.

PRACTICAL: Intended for hard work.

LAST A LIFETIME.

The "RESEARCH" Microscope.



Specification:—

Mechanical Stage—Giving movements 2″ × 1⅝″. Both milled heads on same axis.

Fine Adjustment — Side limb, vertical lever type.

Coarse Adjustment — Diagonal rack, long range, enables 3″ objective to be focussed when on nosepiece.

Compound Substage—Rack and pinion focussing with centering screws for condenser.

Movements are slotted and sprung throughout, and wear can be at once compensated.

Tripod foot giving stability in any position.

Guaranteed for 5 years.

For the Amateur or Professional this instrument embodies every desirable movement, and is at once **the cheapest and the best obtainable.**

Prices:—,

Research Microscope £12 10 0

do. do. with eyepieces No. 2 and No. 4, objectives 1″ and ⅛″ (1 mm. working distance for pond life or blood counts), aplanatised Abbe illuminator with iris diaphragm. In mahogany case **17 17 6**

Full details of the above, and also of ***32 Different Models*** *at all prices, will be found in* ***Watson's Microscope Catalogue, No. 2k,*** *which will be forwarded gratis on application.*

APPARATUS FOR:—

PHOTO-MICROGRAPHY. POND LIFE.
METALLURGY. PETROLOGY.
BACTERIOLOGY. PROJECTION.
HÆMATOLOGY, &c., &c.

W. WATSON & SONS, LTD.,

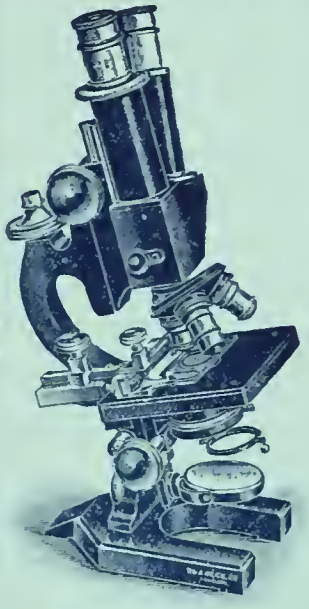
Contractors to H.M. Governments,

313 HIGH HOLBORN, LONDON, W.C.

BRANCHES:
16 Forrest Road, Edinburgh; 196 Great Portland Street, London, W.
DEPÔTS:
2 Easy Row, Birmingham; 78 Swanston Street, Melbourne, Australia; 212 Notre Dame Street West, Montreal, Canada.

Optical Works—HIGH BARNET, HERTS. ESTABLISHED 1837.

The BECK BINOCULAR



BECK BINOCULAR MICROSCOPE.
No. 1031 P.S.

(Patent applied for)

Not only an advance on previous Binoculars, but better than a Monocular with all powers.

1. Resolution equal to that of a Monocular.
2. Equal illumination in both eyes.
3. Short tube length, making Microscope compact.
4. No special object-glasses or eyepieces required.
5. Standard angle of convergence.
6. Stereoscopic vision.
7. Binocular vision, saving eyestrain and giving better results than Monocular vision.
8. Converted into a Monocular by a touch.

Full descriptive Booklet and Price List on application.

R. & J. BECK, Ltd., 68 Cornhill, London, E.C.

DENT'S CLOCKS

WATCHES AND CHRONOMETERS

FOR SCIENTIFIC USE.

Sidereal or Mean Time Clocks for Observatories, £21 and upwards.

THREE GRAND PRIZES AND ONE GOLD MEDAL FRANCO-BRITISH EXHIBITION.

The only Grand Prize awarded to a British Firm for Watches, Clocks and Chronometers.

The only Grand Prize awarded for Astronomical Regulators, Chronographs, and Ship's Compasses.

DENT TRADE MARK

61, STRAND, and 4, ROYAL EXCHANGE, LONDON.

Telephone No. 61 City.

— JOHN KING, "Knowledge" Printer of —

UXBRIDGE, SOUTHALL, AND EALING,

is favourably equipped for the

PRINTING OF SCIENTIFIC BOOKS, BROCHURES, &c.,

and will be pleased to submit Estimates.

Address all Communications to 213, Uxbridge Road, Ealing, London, W.

TELEPHONE: 1144 EALING.

CAUTION.—*The Proprietors of* **SCHWEITZER'S "COCOATINA," "FAIRY COCOA," &c.,** *beg to inform their clients that NONE of their products are manufactured in Germany; that they are a private ENGLISH COMPANY managed by a Board of ENGLISH DIRECTORS; and that all shares are held by relatives and connections by marriage of the late sole proprietor, Captain Thomas Edward Symons, R.N.*

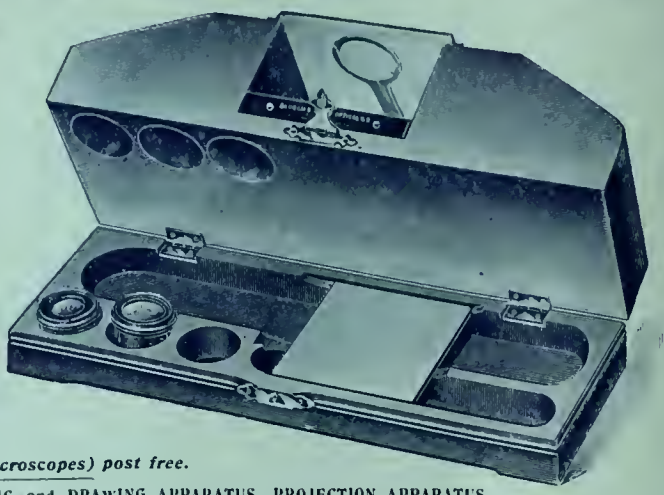
. FOR .

ZOOLOGY & BOTANY CLASSES & FORESTRY WORK.

Adopted by Agricultural and other Colleges under various Government Departments.

Bausch and Lomb

DISSECTING MICROSCOPE.



The best Instrument of its kind.

Has hinged base provided with suitable receptacles for magnifiers and dissecting instruments used in the work.

Complete with two Coddington lenses, 38mm. and 19mm., **17s. 6d.**

Inland parcel post, 6d. Foreign, 1s. 6d.

MICROSCOPES FOR ALL REQUIREMENTS UP TO THE MOST ADVANCED RESEARCH.
OVER 100,000 SOLD, WHICH ARE IN USE THROUGHOUT THE WORLD.

Call and inspect at our New Showrooms, or ask for List "A 2" (Microscopes) post free.

Also particulars of MICROTOMES, PHOTO-MICROGRAPHIC and DRAWING APPARATUS, PROJECTION APPARATUS, CENTRIFUGES, GANONG'S APPARATUS for PLANT PHYSIOLOGY, VISCOSIMETERS, &c., on application.

N.B.—ALL OUR INSTRUMENTS BEING MADE AT OUR OWN FACTORY IN ROCHESTER, N.Y., THERE WILL BE NO DELAY IN DELIVERY, AND WE HAVE JUST RECEIVED LARGE STOCKS.

BAUSCH & LOMB OPTICAL CO.,

Contractors to British and Foreign Governments,

37-38, HATTON GARDEN, LONDON, E.C.

Trade Mark. [*Telephone: Holborn 2640.*] OR THROUGH ALL DEALERS. [*Telegrams: "Optibalop, London."*] Trade Mark.

Dr. A. HUTCHINSON'S NEW UNIVERSAL GONIOMETER

For the Examination of Small Crystals and Mineral Grains.

This instrument can be used for any of the following purposes:—
As an Ordinary Goniometer for the Measurement of Angles.
As an Axial-angle Apparatus.
As a Kohlrausch Total-reflectometer.
For Determining Refractive Indices by the Prism Method.
For Experimental Work in Mineralogy.

Descriptive Pamphlet on Application.

JAMES SWIFT & SON,
UNIVERSITY OPTICAL WORKS,
81, TOTTENHAM COURT ROAD, LONDON.

GLASS-TOP BOXES,

BOTH CARD & WOOD, FOR COLLECTORS, MUSEUMS, &c., for STORING SHELLS, EGGS, COINS OR OTHER OBJECTS.

In all sizes, both round and rectangular.

See Catalogue "C," post free.

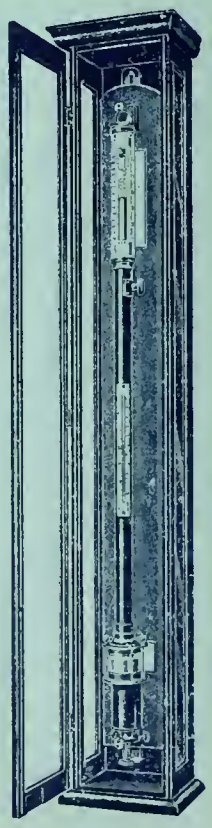
FLATTERS & GARNETT, Ltd.,
MAKERS OF LANTERN AND MICROSCOPE SLIDES,
309, OXFORD ROAD (Opposite the University), MANCHESTER.

PASTORELLI & RAPKIN,

(Estab. 1750.) Ltd.

46, HATTON GARDEN, LONDON E.C.

ACTUAL MANUFACTURERS of all kinds of Meteorological Instruments.



STANDARD INSTRUMENTS.

(With Kew Certificates, if desired.)

Fortin's Barometers.
Maximum Thermometers.
Minimum Thermometers.
Hygrometers.
Earth Thermometers.
Sunshine Recorders.
Rain Gauges.
Anemometers.
Self-registering Rain Gauges.
Self-recording Barometers. Thermometers. Rain Gauges. Anemometers.
Etc.

☛ *Illustrated Price List Post Free.*

Contractors to H.M. Government.

Telephone: 1981 Holborn. Telegrams: Rapkin, London.

*** We pay carriage and guarantee safe delivery within U.K. on all our Instruments.

Printed for the Proprietors (Knowledge Publishing Company, Limited), by John King, Ealing and Uxbridge.—April, 1915.